Appendices

RP3 Business Plan

2020-2024

NATS (En Route) plc

26 October 2018

Contents

Appendix A: Mapping of our business plan to CAA's evaluation components and guidance

In Appendix C of CAP 1625, the CAA set out the key components of their evaluation of our business plan. The CAA followed up with further guidance on their expectations in letters in May and September 2018.This appendix sets out how and where we have provided the corresponding information in this business plan.

CAA evaluation component	Description	Business plan reference
Accountability	How well has NERL ensured it is effectively accountable to its customers, shareholders and other external stakeholders, consistent with the appropriate principles of corporate governance. NERL needs to explain how it will take ownership and accountability for airspace modernisation.	Chapter 9 describes the processes through which we discharge our accountability. Our proposed accountability for airspace modernisation is described in Chapters 7 and 9.
Quality of stakeholder engagement	How well has NERL understood the needs of its customers and other external stakeholders, both today's and tomorrow's, and translated that understanding into its business plan, including issues raised by the CAA's Consumer Panel.	Chapter 2 and Appendix C describe our engagement with stakeholders to date, and how this has informed our business plan. Chapter 9 describes how we have addressed a number of issues raised by the CAA's Consumer Panel.
Shared governance arrangements	How well has NERL built on the shared governance arrangements for NERL's capital programme, ensuring they are robust and meaningful.	Proposals for how we will build upon current shared governance arrangements are described in Chapter 9. Appendix L describes proposals developed during the consultation with our customers for enhancing governance arrangements to make them more robust and meaningful.
Business resilience and risk-management	How has NERL understood and evaluated the broader risk environment and secured that its business plan is resilient to future uncertainty.	Chapters 1, 4 and 8, and Appendix O describe the broader risk environment, and how we will ensure our plan is resilient against uncertainty. Residual uncertainties which could exist after our business plan is submitted, and how these could be dealt with, are described in Chapter 7.
Capital expenditure	How well has NERL developed: – Its broader business strategy to meet the needs of its external stakeholders; – Its corresponding investment strategy for RP3 and beyond; – Its optioneering of the investment programme; – Robust cost benefit analysis, including assessment of potential efficiency gains and value for money; – The resilience and adaptability of the programme to future uncertainties; and – Efficient costing for the purpose of either informing shared governance of the investment programme or the baselines for any financial incentives.	Our capital expenditure proposals which take into account external stakeholder priorities, including costs, are described in Chapters 5 and 8. Further detail is provided in Appendices L and M. Capital expenditure governance is described in Chapter 9. Options within our core plan are set out in Chapter 6. Information on our efficient costing is provided in Chapter 5.

CAA evaluation component	Description	Business plan reference
Operating expenditure (including operational resilience but excluding pensions deficit funding)	How well has NERL understood the implications of its customer-focused business and investment strategy for its operating expenditure and how well has it translated that understanding into forecasts of efficient cost levels. This needs to cover NERL's response to Project Oberon as well as trade-offs against other options, including the European Commission's Performance Review Body's recommendations for EU-wide targets (latest advice dated 30 September).	Our operating expenditure proposals are set out in Appendix H, with supplementary information in Appendices I, J and K, and NERA's report on staff costs.
NERL/NSL boundaries	Recognising the degree of interaction between NERL and NSL, how well has NERL laid out and evidenced how services between it and NSL are priced on a fair, commercial and arm's length basis and cost allocations are made on an objectively fair basis. This needs to cover both the principle and practical levels, how value for money is provided to its customers, and including examples of Aireon, electronic conspicuity/drones and the UK airports air traffic business.	Information on the governance around NERL and NSL boundaries is provided in Chapter 9.
Traffic volumes	Are NERL's forecasts, including any adjustments to take account of downside shocks, reasonable, balanced and evidence based.	Information on our traffic forecasts is provided in Chapter 1. Our traffic forecast methodology is provided in Appendix B.
Performance targets	How well has NERL developed its proposed KPIs for safety, environment and capacity during RP3 to meet the needs of external stakeholders and related evidence-based stretching performance target levels.	Information on our RP3 performance targets is provided in Chapter 3, with supplementary information in Appendices D, E, G and H.
Incentive and risk sharing mechanisms	How well has NERL designed its proposed incentive and risk-sharing mechanisms to help ensure its management will be effective in benefiting external stakeholders. This would include providing for: – A balance between operating expenditure and traffic risk-sharing that relates to the underlying cost elasticity; – A balance between financial incentives and shared-governance, recognising that shared-governance arrangements are an alternative way to protect the interest of customers; – A balance between cost and performance incentives that fairly reflects the value to the consumer; and – A residual risk profile for NERL's investors, expressed in terms of impacts on the return on regulatory equity (RoRE) that is consistent with its ability to finance its activities at an efficient cost of capital.	Proposals on incentive and risk sharing mechanisms are set out in Appendices I and O.
Pensions deficit funding	How well has NERL framed its consumer-led strategy for pensions, including how it seeks to manage the risk of stranded surpluses and any high-cost de-risking in a way that is in the interest of customers.	Our proposals related to pensions are provided in Appendix H.

CAA evaluation component	Description	Business plan reference
Cost of capital and financeability	How well has NERL: – Framed its cost of capital assumptions in light of current and emerging views from the CAA (including for Heathrow airport as set out in CAP 1610), other regulators and other authorities; and – Developed its plan, in light of a reasonable range of possible estimates of the cost of capital by the CAA, to be consistent with its continuing need to raise finance as well as justifying matters relevant to NERL's financeability.	Our cost of capital proposals is set out in Appendix P supported by two NERA reports. The outcome of financeability testing is provided in Appendix Q. A full set of results will be supplied to the CAA separately.
Suitability and integrity of NERL's financial forecasting model	Does its financial forecasting model meet best practice standards for a model used for regulatory price control purposes, including providing assurance to customers and the CAA and any limitations thereof.	A copy of our financial model containing our plan will be supplied to CAA separately. The financial model was developed in RP2 to conform to best practice standards and to enhance logical integrity and usability. A description of the independent testing that has been carried out by independent consultants on key aspects of the financial model is provided in Appendix Q.
Electronic conspicuity	NERL's vision for implementation, including landscape, challenges, benefits (safety and capacity) and costs. This should extend beyond RP3 where possible.	Information on NERL's proposals for electronic conspicuity is provided in Chapter 7.
Oceanic	Evidence relating to NERL's benefit assumptions (including downside risks), efficiency of proposed data charges and rationale for pass through of data charges to users (including appropriate allocation of risks).	Information on NERL's justification for investment in the Oceanic business is provided in Appendix M.
London Approach	Impact on plan of changing scope to include London Biggin Hill Airport and charging basis as well as proposals for effective monitoring of performance.	Further information about London Approach is provided in Appendix O.
Mitigation of noise	NERL should explain the levers it has to mitigate noise, along with any trade-offs with other externalities, and limitations of the levers.	Chapter 3 describes NERL's approach to the mitigation of noise.

Appendix B: Our traffic forecast

UK air traffic movements (ATMs) are made up of a number of different types of movements: passenger, overflights, cargo, business and military. The factors that affect each of these are different and, therefore, each needs to be considered separately in the forecast before being combined to give the total UK ATMs.

Flights can also be broken down into market segments based on which markets they serve. These are: domestic (around 15% of flights), transatlantic and non-transatlantic arrivals and departures (6% and 64% of flights respectively), transatlantic and non-transatlantic overflights (9% and 6% of flights respectively).

Our forecasting methodology covers a number of different elements, which are then combined to produce the ATM forecast. Two forecast methods are used:

> A passenger allocation model (PAM) for scheduled, chartered, and low cost operations; and

> Statistical techniques for overflights, cargo, business flights and military operations that are forecasted separately outside of the PAM.

In August 2017 we acquired the Department for Transport's (DfT) aviation forecasting model. This is a comprehensive model developed and maintained by the DfT to support production of forecasts for passengers, aircraft movements and CO_2 emissions at UK airports[1]. The model was used extensively in the Airports Commission's analysis to appraise capacity options and during this time the model was extensively peer reviewed. This model is used by our analytics team, together with updated assumptions set out in this document to forecast traffic movements for UK arrivals/departures.

For over 20 years, as an input to our forecasts, we have used economic forecasts provided by Oxford Economics. They are a well respected economic forecasting and consultancy company. We produce one forecast each year, with the base forecast typically released around December. High and low variants of the forecast are produced early the following year.

This methodology allows a UK ATM forecast to be created, along with forecasts for en route service units (SU), the mechanism through which flights are charged for the air traffic service. SUs are a function of a flight's weight and great circle distance through the UK. Two SU forecasts are created; these cover chargeable service units (CSU) and total service units (TSU) – made up of CSUs and civil and military exempt flights.

Our forecast assumptions

Our August 2018 base case forecast represents the most likely scenario and is based on the July 2018 Oxford Economics central economic forecast with a 50% probability, along with our assessment of the most likely evolution of other influencing factors.

The main assumptions that are included in the forecast are:

> Actual traffic - January to July 2018;

> GDP assumptions;

> Other economic assumptions – UK consumption, airline fares incorporating airline fuel, carbon and other costs;

> Airport capacities;

> Route level load factors;

> Overflights;

> Cargo; and

> CSUs calculated for each market segment.

[1] DfT UK aviation forecasts, October 2017. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/653821/uk-aviation-forecasts-2017.pdf.

Our August high case forecast represents an optimistic outturn associated with the Oxford Economics July 2018 economic scenario called 'central banks delay policy tightening' with a 10% probability, and our assessment of the most optimistic evolution of other influencing factors (e.g. airport capacities, overflights etc.). This assessment includes a lower oil price forecast more in line with our base forecast which, combined with the higher GDP of this scenario, leads to higher traffic growth.

Our August low case forecast represents our view of a credible low growth scenario, and is associated with the Oxford Economics July 2018 economic scenario called 'synchronised global slowdown' with a 10% probability, and our assessment of the low case evolution of the other influencing factors.

Actual traffic

Actual traffic data for January to July 2018 is included in our 2018 base forecast. Traffic for the remaining months of 2018 was estimated to give an estimate for the full calendar year.

In late February and early March 2018, the UK was hit by a series of snow and storms. This resulted in a number of days of flight cancellations at airports in the UK. While we have made no change to the 2018 historical data, we have adjusted the 2019 growth rates to account for these cancelled flights.

GDP

While UK GDP is not directly correlated with traffic growth, GDP continues to be a significant driver of passenger demand. This is because economic growth results in higher passenger demand through increased disposable income and economic prosperity.

The Oxford Economics July 2018 GDP forecast has been used in our forecast. UK GDP is forecast to be 1.3% for 2018 and 1.5% in 2019. GDP is forecast to increase to around 2% p.a. for the duration of RP3. This reflects continued uncertainty around Brexit, rising oil prices and a small downward revision for on-going trade tensions between the US and China, and the US and the EU. This baseline economic forecast has been given a 50% likelihood by Oxford Economics.

While UK GDP is the main driver of passenger demand in the UK, GDP forecasts for other countries also influence the traffic that passes through the UK. In addition to the UK GDP, GDP forecasts for Europe, Organisation for Economic Co-operation and Development (OECD) (dominated by the US GDP), newly industrialised countries (NIC) (dominated by China and India) and less developed countries (LDC) are also used in the forecast. The GDP growth rates used in our August 2018 base forecast are shown in the table below.

Oxford Economics July 2018 forecast GDP growth for RP2 and RP3

	2018	2019	2020	2021	2022	2023	2024
UK	1.3%	1.5%	2.0%	2.2%	2.1%	2.1%	1.9%
Europe	2.0%	1.8%	1.7%	1.6%	1.5%	1.4%	1.3%
OECD	2.5%	2.1%	1.6%	1.7%	1.7%	1.7%	1.6%
NIC	4.5%	4.3%	4.0%	4.1%	4.0%	3.9%	3.8%
LDC	3.3%	3.8%	4.1%	4.1%	4.2%	4.2%	4.1%

Our August 2018 high forecast is based on the economic scenario produced by Oxford Economics called 'central banks delay policy tightening'. This is their most optimistic scenario with a 10% probability. UK GDP growth in this scenario is forecast to be 1.4% for 2018 and 1.7% in 2019; and between 2.0% and 2.4% for the duration of RP3.

Our August low case forecast is based on the Oxford Economics scenario called 'synchronised global slowdown'. This is their most pessimistic scenario, and also has a 10% probability. UK GDP growth in this scenario is forecast to be 1.3% for 2018 and 1.5% in 2019; and between 1.9% and 2.2% for the duration of RP3. It is worth noting that as load factors are currently at an all time high, lower levels of GDP growth would reduce passenger demand, but we do not expect that flight volumes would be affected to the same extent.

Economic uncertainty

There are a number of factors that could affect our traffic forecast. In particular, there is significant uncertainty related to economic forecasts for 2019-2024, affecting our RP3 plan. This is particularly the case with the current unknowns around Brexit and the effect this may have on the UK economy over the coming years. While the full effects of Brexit are unlikely to be understood prior to the start of RP3, the progress of negotiations over the next few months could give significantly more information about the nature of Brexit and its possible impact on the UK economy. In these circumstances, we would look to the CAA to keep the forecast under review given the higher degree of uncertainty.

Oxford Economics baseline GDP forecasts reflect what they consider to be the most likely outcome. Risks, such as a UK recession or a global trade war, are not considered to be the most likely outcomes. Therefore, these are not included in the Oxford Economics baseline GDP forecast. Should the likelihood of such risks increase sufficiently then the baseline forecast would be updated to include these.

Other economic assumptions

The forecast for UK consumer spending growth is taken from the Oxford Economics July forecast.

The model includes an airline fares component which incorporates airline fuel, carbon and other costs.

Fuel is a considerable operating cost for airlines and impacts their ability to service passenger demand. Our forecast assumes a representative hedging strategy across the sector, which reflects airline practices, resulting in a profile of fuel cost forecast changes that are more robust. The average spot price of Brent crude oil is forecast to rise from an average of US$75 per barrel to US$80 per barrel by 2024 in the Oxford Economics July forecast and represents a considerable increase from the forecast in the plan we developed for the RP3 customer consultation, the starting point of which was US$50 per barrel. This, in part, contributes to the slower growth rate in traffic in 2018 and 2019 of the forecast in this plan.

Carbon costs included in the fares model are in line with the UK Department for Business, Energy and Industrial strategy March 2017 values.

Airline other (non-fuel) costs are calculated as the difference between the quantified components of airline costs and the air fare.

Air passenger duty (APD) is based on HM Revenue and Customs April 2017 APD and is assumed constant through the forecast.

Airport capacities

Airport capacities, both terminal passengers and runway, are a key constraint on the translation of passenger demand into flights. Our forecast of future airport capacities is based on airport master plans, published airport capacities, and insights obtained from airports themselves and our airports and consultancy team. The table below on the left details the forecast growth in airport capacities to the end of RP3 at London terminal manoeuvring area (LTMA) airports. The table below on the right details the forecast growth in capacity for other key UK airports.

Forecast growth in airport capacity[2] at LTMA airports

Airport	Growth 2017-2024
Redacted	

Forecast growth in airport capacity at other UK airports

Airport	Growth 2017-2024
Redacted	

[2] This relates to ATM capacity i.e. aircraft movements. There may be growth in passenger numbers due to a larger aircraft size or increased load factors. These factors are captured separately within the forecasting model.

No additional runways are assumed for the full period of the base or high forecasts, as a third runway at Heathrow will not be in place until the mid-2020s. Therefore, this is unlikely to impact on the traffic forecast during RP2 and RP3, though our plan needs to prepare for the expected increase in traffic generated from a new runway in early RP4.

Redacted

The constraints of airport capacities, particularly in the LTMA where the passenger demand is the highest, will restrict the potential growth of ATMs.

Load factors

Load factors are a key variable in determining growth in ATMs. The PAM includes load factors for individual routes over the entire forecast horizon. The table below gives an overview of average load factors by market segment.

Average load factor by market

Market	Load factors	Comment
Europe	~85%	Higher load factor as a result of higher proportion of low cost carriers
Domestic	~75%	Load factor consistent with a large proportion of legacy carriers
OECD	~75%	
NIC	~75%	
LDC	~75%	

Load factors remain at or near record highs. This means that load factors are less likely to absorb passenger growth which therefore leads to increased ATMs. Conversely if passenger growth declines, load factors could absorb this to some extent before ATMs reduce.

Overflights

Overflights account for around 15% of UK flights and are split into transatlantic and non-transatlantic overflights. Non-transatlantic overflights are dominated by traffic between Ireland and Europe.

Overflights are forecast to continue to grow at an average annual growth rate of 3.4% for transatlantic overflights, and 6.8% for other overflights. Growth in these markets is not restricted by the airport capacities in the UK and is driven by economic growth in the US, Europe and Ireland. The overflight flows will continue to be a key driver of ATM growth within the UK flight information region (FIR).

Cargo

Cargo flights accounted for 2.4% of UK arrivals/departures in 2017. The table below gives the forecast growth in cargo flights for each market. Cargo overflights are included in our forecast of overflights.

Forecast average annual growth in cargo flights

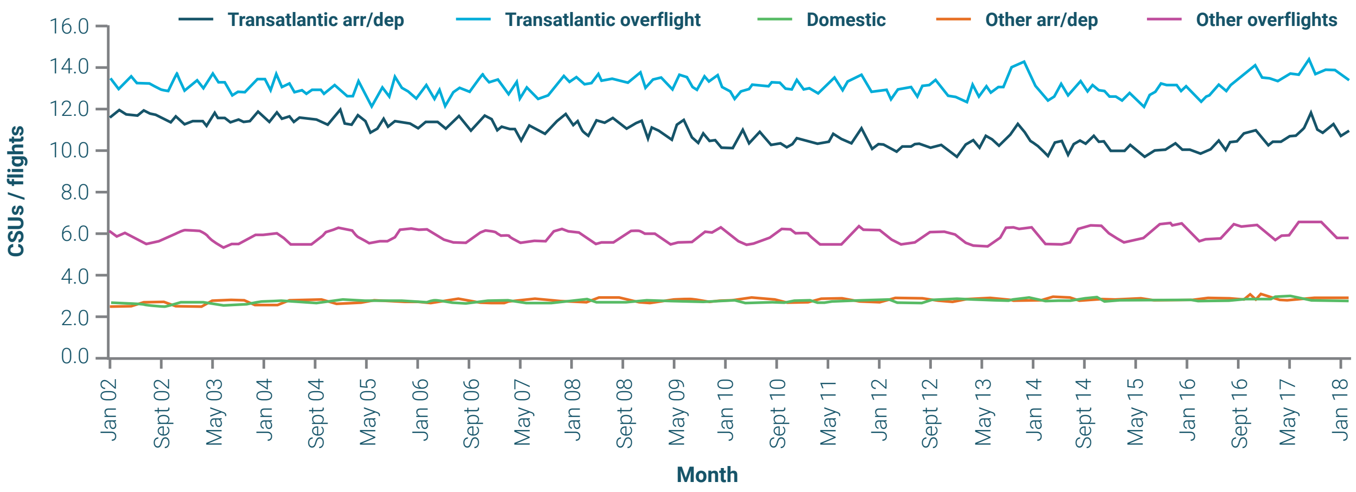
Market	Average annual growth rate 2017-2024
Domestic	1.8%
North America	1.4%
Europe	0.6%
Rest of world	-0.1%
Total	1.1%

In recent years the growth of cargo flights has slowed as a result of the increase in freight in the hold on passenger flights.

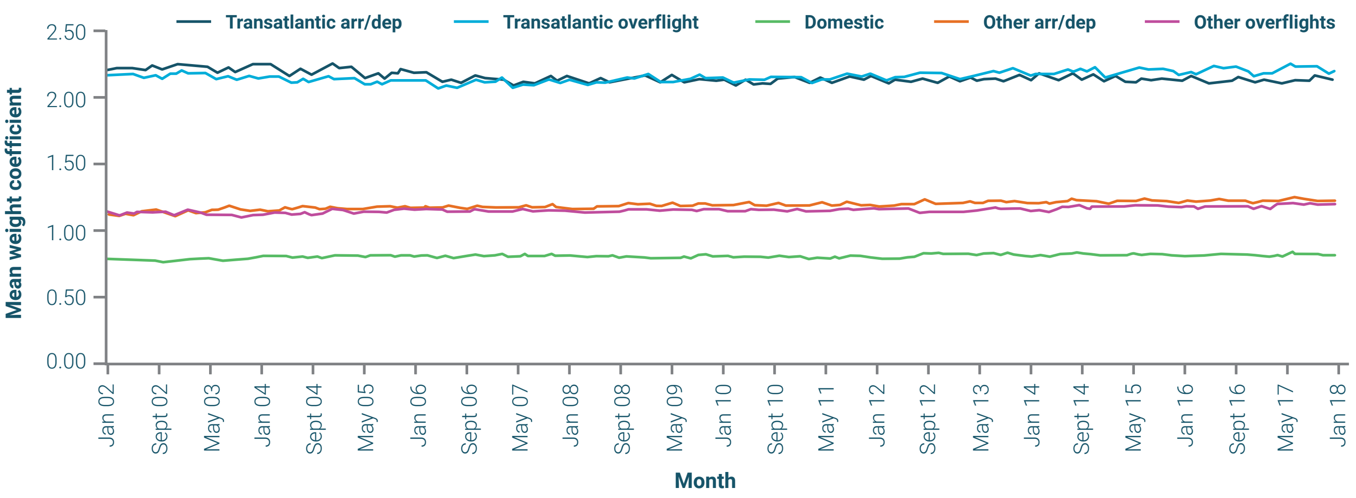
Chargeable service units

Forecast service units are calculated for each market segment due to the variations in the number of CSUs per flight. The charts below show the historical variation in average CSUs per flight, mean weight coefficient and average distance flown for each market segment.

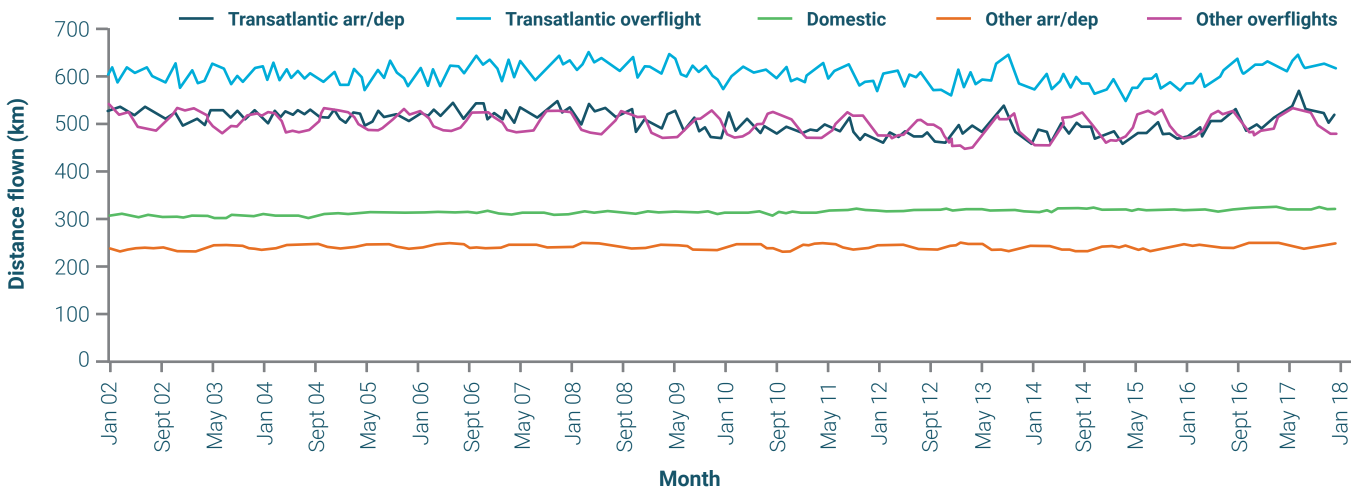
CSUs per flight for chargeable traffic



Mean weight coefficient for chargeable traffic



Average distance flown for chargeable traffic



While within each market segment the average weight remains reasonably stable, the average distance flown strongly influences the average CSUs per flight. Average CSUs per flight are lower and more stable for non-transatlantic arrivals/departures and domestic as a result of the shorter distances flown for these routes. Other overflights show seasonal variability due to the variation in European destinations from Ireland, but have a relatively stable annual average.

The transatlantic arrivals/departures and overflights have much higher CSUs per flight, these flights typically account for only 15% of flights but around 40% of chargeable service units. There is also variation in the average CSUs per flight for these market segments as a result of distance flown through the UK FIR due to the location of the jet stream and North Atlantic (NAT) tracks. When the NAT tracks are more northerly, longer distances are flown through the UK FIR. As in 2016, there were more northerly routeings in 2017, particularly when compared with 2015 when south-about tracks dominated the year.

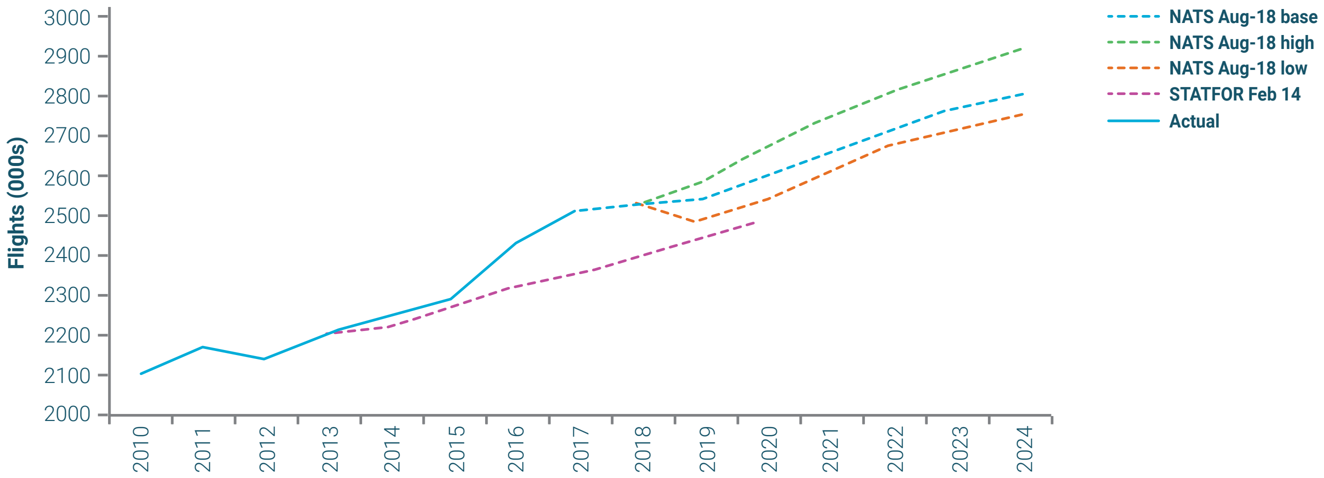
In order to account for the annual variation in the location of the jet stream, and its impact on distances flown in the UK FIR, we have used a rolling five-year average profile of CSUs per flight in our CSU forecast for transatlantic arrivals/departures and transatlantic overflights. This methodology is supported by the UK MET Office in a letter which we made available to our customers and the CAA during the RP3 customer consultation.

Our August 2018 forecast results

UK flights

The chart below includes our August 2018 base, high and low case UK FIR flight forecasts alongside the RP2 (STATFOR[3] February 2014) forecasts for comparison.

UK flights forecast – Aug 18



During 2017, 2,515,746 flights were handled in the UK FIR, representing a 3.7% increase on 2016 (2,425,324 flights). After adjusting for the leap year in 2016, growth was 4.0%.

In 2018 to date, UK FIR flights have increased by 0.5%, representing a marked slowing in traffic growth from the 4.2% year to date growth observed at the same point in 2017. The August 2018 base forecast expects growth for 2018 to be 0.7%.

Our August 2018 base forecast projects UK flight growth for 2019 to be 0.5%. This is because of reduced GDP growth as a result of continued Brexit uncertainty. Our August 2018 high forecast projects growth of 2.0% and our August 2018 low forecast projects a decline of 1.7% in UK flights for 2019.

Over RP2, our August 2018 base forecast projects growth of 13.3%, with the total number of flights being 4.4% higher over RP2 than the STATFOR February 2014 forecast. Our August 2018 high and low forecasts project growth of 14.9% and 10.8% respectively over the whole of RP2.

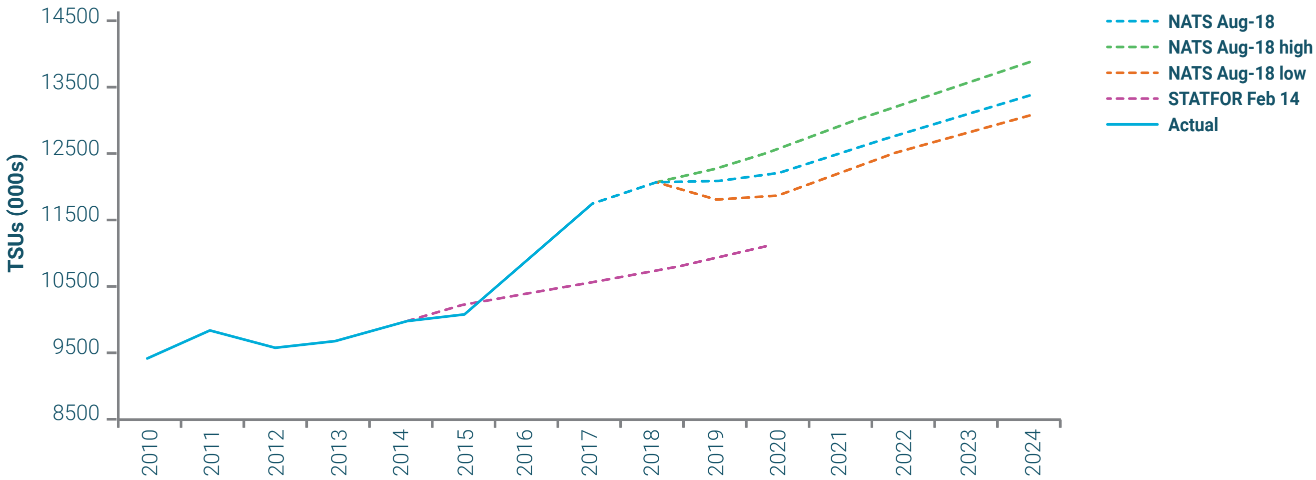
Over RP3, our August 2018 base forecast projects growth of 10.0%. Our August 2018 high forecast estimates growth of 12.8% over the whole of RP3. Our August 2018 low forecast estimates growth of 10.4% over the whole of RP3. This growth rate is marginally higher than our base forecast growth rate, as our low RP3 forecast begins from a lower base at the end of RP2.

[3] Statistics and Forecast service of the Eurocontrol Agency.

Total service units

The chart below shows the TSUs forecast from our August 2018 base, high and low case forecasts along with the RP2 (STATFOR February 2014) forecasts for comparison. TSUs consist of CSUs along with civil and military exempt service units.

Total service units forecast



TSUs grew by 8.7% in 2017. This strong growth, which was more than the increase in flights, was a result of growth in the transatlantic market segments combined with more northerly NAT routeings resulting in longer distances being flown.

For 2018 to date, TSUs grew by 3.4% due to more northerly North Atlantic tracks in the early part of 2018. In recent months the growth rate of TSUs has slowed, with North Atlantic tracks beginning to return to a more central position, and we are expecting TSU growth for 2018 to be 2.7%.

Our August 2018 base forecast projects that TSUs in 2019 will increase by 0.1%. This low growth is a result of the subdued flights forecast for 2019 along with the expectation that the North Atlantic tracks will begin to return to a more central position. Our August 2018 high forecast projects TSU growth of 1.7% during 2019 and our low forecast projects a decline of 2.0%.

Over RP2, our August 2018 base forecast projects TSU growth of 21.0%, which is 7.6% higher than the RP2 (STATFOR February 2014) forecast projections for the same period. Our August 2018 high and low forecast projects TSU growth of 23.0% and 18.6% respectively over RP2.

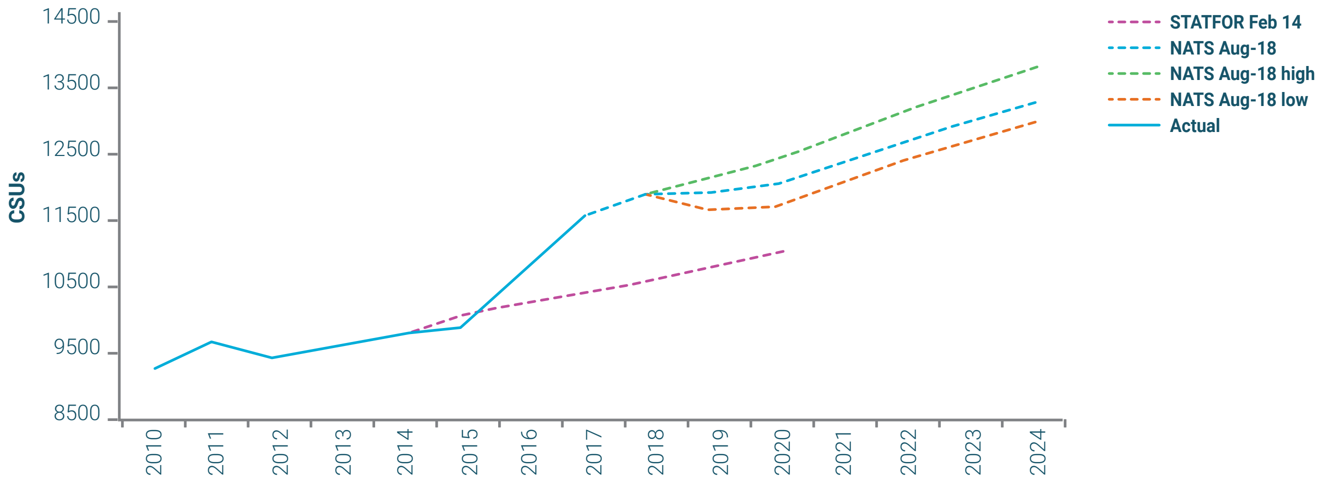
Over RP3, our August 2018 base forecast projects growth of 10.5%. Our August 2018 high and low forecasts project growth of 13.1% and 10.3% respectively over the whole of RP3.

We expect growth in TSU volumes during RP3 to be higher than the growth in flight numbers. This is because we are forecasting stronger growth in transatlantic market segments, in particular, overflights, which have a larger number of TSUs per flight and are not constrained by UK airport capacities.

Chargeable service units

The chart below shows the UK CSUs forecast from our August 2018 base, high and low case forecasts along with the RP2 (STATFOR February 2014) forecasts for comparison.

CSUs



In 2017 CSUs grew by 8.9%. This strong growth, which, similarly to TSUs, was more than the increase in flights, was a result of growth in the transatlantic market segments combined with more northerly NAT routeings leading to longer distances being flown.

For 2018 to date, CSUs grew by 3.6% due to more northerly North Atlantic tracks in the early part of 2018. In recent months the growth rate of CSUs has slowed with North Atlantic tracks beginning to return to a more central position and we are expecting CSU growth for 2018 to be 2.9%.

Our August 2018 base forecast projects that CSUs in 2019 will increase by 0.1%. This low growth is a result of the subdued flights forecast for 2019 along with the expectation that the North Atlantic tracks will begin to return to a more central position. Our August 2018 high forecast projects CSU growth of 1.7% during 2019 and our low forecast projects a decline of 2.0%.

Over RP2, our August 2018 base forecast projects CSU growth of 21.3%, which is 7.5% higher than the RP2 (STATFOR February 2014) forecast projections for the same period. Our August 2018 high and low forecast projects TSU growth of 23.3% and 18.8% respectively over RP2.

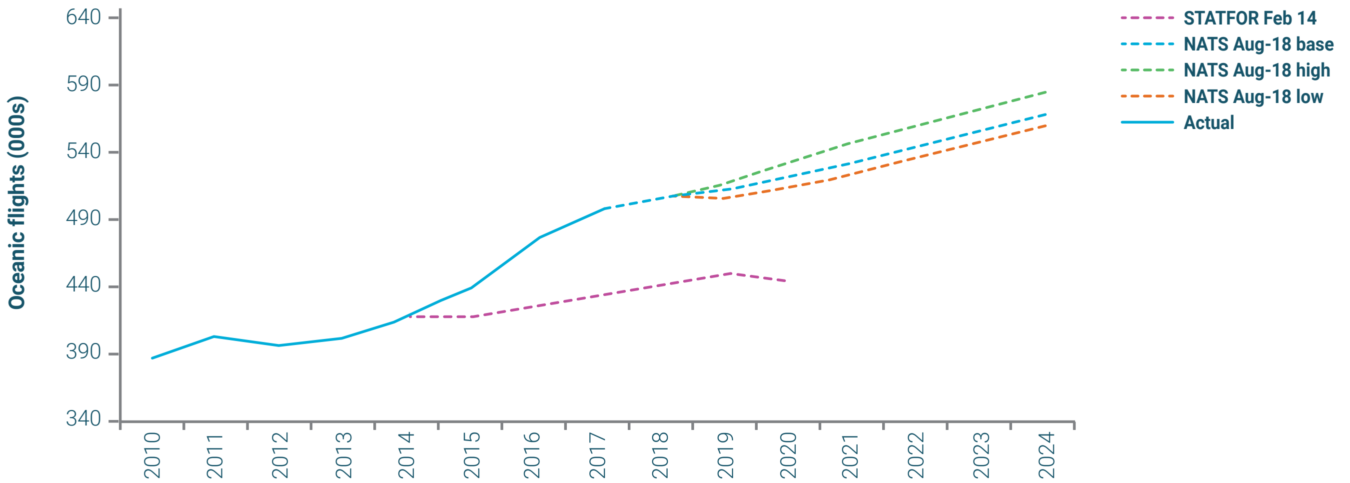
Over RP3, our August 2018 base forecast projects CSU growth of 10.6%. Our August 2018 high and low forecasts estimate growth of 13.2% and 10.5% respectively over the whole of RP3.

The expected growth in CSU volumes during RP3 is higher than the expected growth in flight numbers. This is because we are forecasting stronger growth in transatlantic market segments, in particular, overflights, which have a larger number of CSUs per flight and are not constrained by UK airport capacities.

Oceanic flights

The chart below shows the oceanic flights forecast according to our August 2018 base, high and low case forecasts along with the RP2 (STATFOR February 2014) forecasts for comparison. The oceanic flights forecast includes the transatlantic market segments (overflights and UK arrivals and departures) along with oceanic flights that do not enter the UK FIR.

Oceanic flights forecast



In 2017 oceanic flights grew by 5.1%. This was the result of strong growth in the transatlantic market segments.

Oceanic flights decreased by 0.2% in 2018 to date, primarily driven by a 4.9% decline in January 2018 as a result of flight cancellations in the US during storm Brody. By the end of 2018 we expect oceanic flights to have increased by 2.0%.

Our August 2018 base forecast projects oceanic flights in 2019 will increase by 0.9%. This low growth is a result of the subdued GDP forecasts. Our August 2018 high forecast projects oceanic flight growth of 2.0% during 2019 and our low forecast projects a decline of 0.2%.

Over RP2, our August 2018 base forecast projects oceanic flight growth of 22.5%, which is 11.9% higher than the RP2 (STATFOR February 2014) forecast projections for the same period. Our August 2018 high and low forecast projects TSU growth of 23.8% and 21.2% respectively over RP2.

Over RP3, our August 2018 base forecast projects oceanic flight growth of 11.0%. Our August 2018 high and low forecasts estimate growth of 13.0% and 10.6% respectively over the whole of RP3.

Forecast commentary

The PAM model used in the 2018 forecasts includes all macroeconomic drivers of passenger demand including fares, GDP, consumer spending, oil prices, carbon costs, market maturity, regional population, demographics, propensity to fly and surface access costs.

UK GDP continues to be the main driver of the forecast. In the near term, growth is expected to continue to be subdued as a result of Brexit uncertainty.

Capacity constraints, both runway and terminal, limit the forecast traffic growth, and this impact increases over time. As a result, more passengers to and from the UK are deterred from travelling. The majority of the passengers lost to the UK in the base forecast are transfers at UK hub airports, with international-international transfers switching to competing overseas hubs. Domestic-international transfers are also impacted and will instead use direct flights after travelling by surface modes to an alternative airport, with some new routes being stimulated at less congested airports.

Outside of London and the south east, the higher levels of lost travel are in Scotland and can be largely attributed to the high demand for interchanges at the congested London airports and the loss of several domestic flights to London.

STATFOR February 2018 forecast

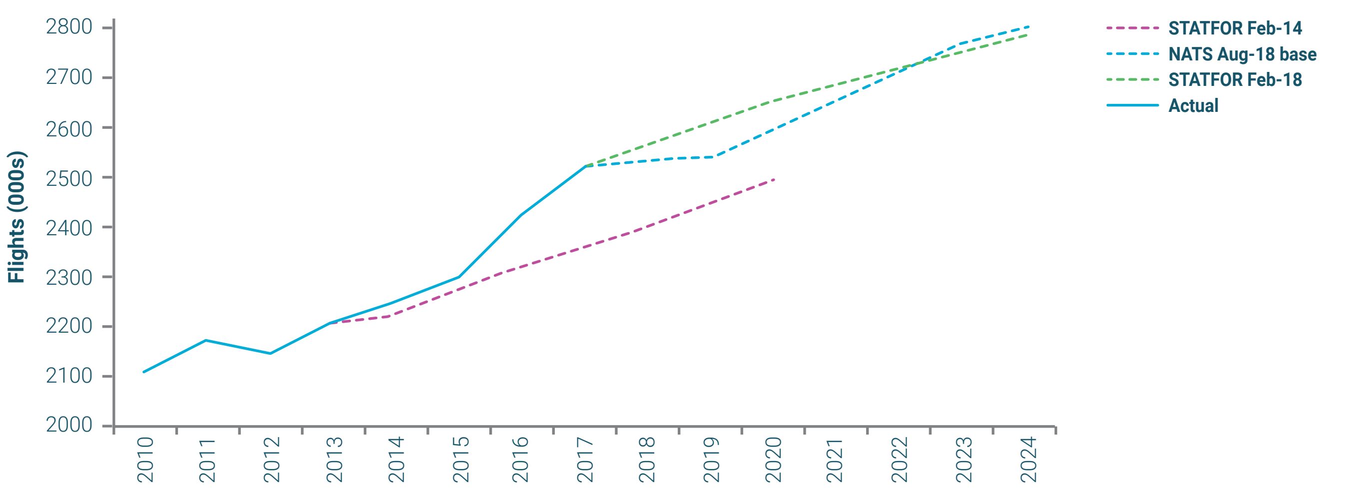
The latest Eurocontrol STATFOR seven-year forecast (February 2018) was issued at the end of March. A key input to the STATFOR forecast is Oxford Economics January 2018 UK GDP forecast, as shown in the table below. Our August forecast, which was produced six months later, uses Oxford Economics July 2018 UK GDP forecast.

Oxford Economics January 2018 forecast GDP growth for RP2 and RP3

	2017	2018	2019	2020	2021	2022	2023	2024
UK	1.8%	1.5%	1.6%	1.9%	1.9%	1.9%	1.9%	2.0%

The STATFOR February 2018 UK flights forecast is shown in the chart below, along with our August 2018 base forecast for comparison. STATFOR expect growth in UK flights of 1.8% in 2018, with growth of 16.0% over RP2 and 7.1% over RP3. On average the STATFOR forecast for UK flight numbers is around 0.5% higher than our forecast over RP3, however, our forecast ends RP3 0.3% higher. At the time of writing this plan, STATFOR's September 2018 forecast was not available.

STATFOR February 18 flights forecast



The STATFOR February 2018 TSU forecast is shown in the chart on the next page along with our August 2018 forecast for comparison. STATFOR projects TSU growth of 2.5% in 2018, with growth of 23.6% over RP2 and 9.0% over RP3. On average the STATFOR forecast for TSUs is 1.7% higher than our forecast over RP3.

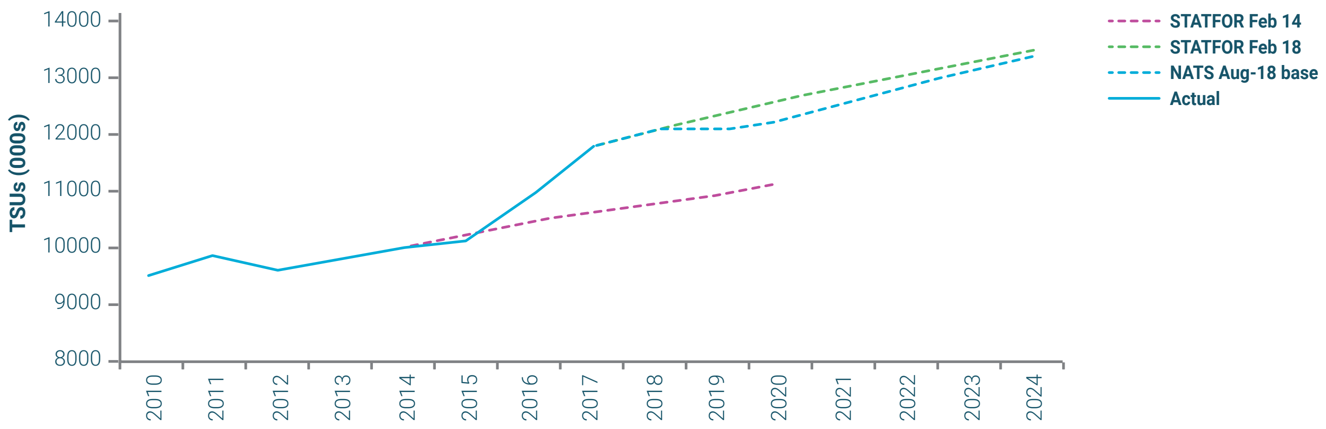
The TSU growth forecast by STATFOR is based on the latest trends in flown distance and aircraft weights observed. STATFOR note that the UK saw particularly strong growth in TSUs in 2017 as a result of transatlantic flights flying more north-about trajectories, due to the position of the jet stream. The STATFOR methodology uses trends in actual flown distances for the market segments (overflights, international arrivals/departures and domestic) to project forecast distance flown for future years.

This is likely to overstate the UK TSU volumes for RP3 because this methodology does not separately model market segments for transatlantic overflights and transatlantic arrivals/departures, which would enable the position of the jet stream to be reflected directly within the forecast. This is a considerable limitation of the STATFOR forecast methodology which particularly affects the UK as the transatlantic markets account for around 40% of TSUs.

If no adjustment is made for a normalisation of the position of the jet stream, which we have begun to see in 2018, then we expect the September 2018 STATFOR forecast to include an overstatement of TSUs in relation to this factor. This could be material.

At the time of writing this plan, STATFOR's September 2018 forecast was not available.

STATFOR February 2018 TSU forecast



Commentary on STATFOR

Within the STATFOR report that accompanies their forecast, STATFOR highlight the downside risks to the flight and TSU forecasts, particularly the Brexit uncertainties. They also note that an increase in aircraft size and increases in load factors may also reduce the rate of flight growth.

There are a number of differences in the forecast methodologies used by STATFOR and us. One of the main differences is that, unlike our model, STATFOR's PAM does not reallocate passengers to alternative airports if their nearest airport reaches capacity. We believe that the inclusion of passenger reallocation in PAM makes our forecast more realistic for the UK.

In addition to the differences in the methodologies for forecasting flights, there are also differences in the methodologies used to forecast TSUs.

The STATFOR forecast assumes a constant level of growth in TSUs based on historical data for TSUs per flight. This does not take into account the variations of SU across the different market segments and, in particular, the transatlantic market segment which strongly influences the average TSUs per flight. As a result of this, the latest STATFOR forecasts for TSUs assume continuing growth in TSUs because of experience in 2016 and 2017 as a result of the more northerly position of the NAT tracks. This leads to an overstatement of around 2% in TSU volumes over RP3.

While military and civil-exempt flights account for only a small proportion of the flights and service units, these are projected to grow at the same rate as other flights in the STATFOR forecast. Our forecast assumes these flights will remain fairly constant, which we believe is a more realistic assumption.

For the reasons given above, we believe that our traffic forecast is more appropriate for the UK.

Forecast sensitivities

Our August 2018 base case forecast is sensitive to the assumptions made within it, as outlined above. While these assumptions are made with the best knowledge and intelligence available at the time, there are inherent risks within forecasting.

The Oxford Economics base case GDP growth forecast has been given a 50% probability of fruition. Currently the global economic risks are balanced, with 10% probability of central banks delaying policy tightening and a 10% probability of synchronised global slowdown. Other scenarios focus on trade wars, with an upside scenario that the fears dissipate and a downside that they affect global growth.

Although Brexit presents a downside risk to economic growth in the UK and Eurozone it is expected to have little impact on the wider global economy, and hence have limited impact on overall passenger demand. Oxford Economics update their global risk scenarios every quarter in line with political events and risks.

The possible extent of these uncertainties can be seen in the differences in the UK GDP forecasts between different forecast sources. For example, Oxford Economics GDP forecast (used in our forecasts) of around 2% per annum for RP3 exceeds the OBR GDP forecast of around 1.5% per annum for the same period.

This base case forecast represents the most likely path for future traffic levels, with the assumptions relating to most likely industry and economic conditions. However, the base case forecasts should be considered in conjunction with the high and low cases which reflect respectively a more optimistic outlook for the macroeconomic environment and industry growth, and reasonable downside risks to traffic levels.

Our August 2018 high forecast represents an optimistic outturn associated with central banks delaying policy tightening economic scenario with a 10% probability.

Our August 2018 low forecast is based on Oxford Economics scenario of synchronised global slowdown. This is their most pessimistic scenario, and also has a 10% probability. Load factors are at an all time high. Therefore, although lower levels of GDP growth would reduce passenger demand, we do not expect that flight volumes would be affected to the same extent.

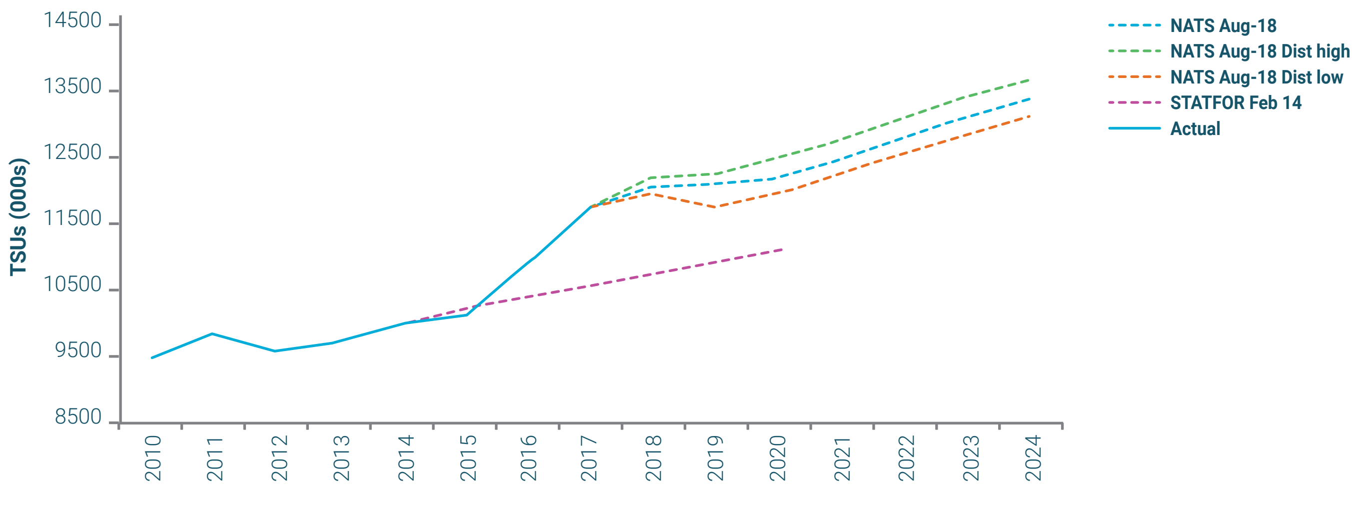
The TSU and CSU forecasts have additional risks as they are a combination of distance flown and weight for each flight. These forecasts are produced by market segment and, while the weights of each of these market segments remain relatively stable, the distance flown can vary, in particular for the transatlantic market segments. This means that even if the number of flights is in line with the forecast, the TSU volume may differ.

The variation of distance flown in the UK FIR for transatlantic flights is due to the location of the jet stream and NAT tracks. When the NAT tracks are more northerly, longer distances are flown through the UK FIR. Similarly to 2016, there were more northerly routeings in 2017, particularly when compared with 2015 when south-about tracks dominated that year.

In order to account for the annual variation in the location of the jet stream, and its impact on distances flown in the UK FIR, a rolling five-year average profile of CSUs per flight is used in our CSU forecast for transatlantic arrivals/departures and transatlantic overflights, which is a methodology that has been endorsed by the UK MET Office. However, by using an average there is an upside risk if the tracks continue to be predominantly north-about, and likewise a downside risk if the tracks return to a predominantly south-about position.

The chart below shows the potential risks to the TSU forecast from the variation in the position of the jet stream. The high distance forecast assumes the same number of flights as our base case forecast, but with north-about tracks for every year of RP3. The low distance forecast assumes the same number of flights as our base case forecast but with south-about tracks similar to those in 2015.

TSUs forecast distance flown variation



When the jet stream is predominantly north-about this could add around 2% to the number of TSUs a year, compared to our base case forecast. Conversely, when the jet stream is predominantly south-about, this could reduce the number of TSUs by 2% a year.

Appendix C: Our understanding of customer priorities

Developing our understanding of customer priorities and requirements

During 2017 we consulted our customers on their priorities and requirements for RP3.

The schedule below lists the 17 airlines and the International Air Transport Association (IATA) with which we held meetings or calls. Also listed are 16 airports that we consulted in 2017. Other airlines, trade associations and airports were offered meetings or calls but did not take up the opportunity.

	Airline/trade body	Date consulted
1	Air Canada	10 Aug 2017
2	British Airways	4 Aug 2017
3	BA CityFlyer	14 Aug 2017
4	Delta Airlines	28 July 2017
5	DHL & European Air Transport	1 Aug 2017
6	easyJet	21 Aug 2017
7	Emirates	7 Aug 2017
8	Flybe	21 July 2017
9	IATA	9 Aug 2017
10	Jet2.com	21 July 2017
11	KLM	21 July 2017
12	Lufthansa Group	7 June 2017
13	Monarch	22 Aug 2017
14	Norwegian Air Shuttle	6 Nov 2017
15	Ryanair	1 Aug 2017
16	Singapore Airlines	30 June 2017
17	TUI	27 July 2017
18	Virgin Atlantic	9 Aug 2017

	Airport	Date consulted
1	Birmingham International	21 Aug 2017*
2	Bristol	23 Aug 2017
3	Doncaster	21 Aug 2017*
4	East Midlands	21 Aug 2017*
5	Edinburgh	21 Aug 2017*
6	Gatwick	5 Jan 2018
7	Glasgow	26 July 2017
8	Heathrow	6 Sep 2017
9	Leeds Bradford	21 Aug 2017*
10	Liverpool	21 Aug 2017*
11	Luton	30 Oct 2017
12	Manchester Airports Group (Manchester)	8 Aug & 21 Aug 2017*
13	Manchester Airports Group (Stansted)	24 July & 21 Aug 2017*
14	Newcastle	21 Aug 2017*
15	Prestwick	21 Aug 2017*
16	Southend	6 Oct 2017

* Consulted at future airspace strategy implementation north meeting at Glasgow Airport.

Confirming our understanding of customer priorities and requirements

During the RP3 customer consultation in the meetings listed below, we confirmed our understanding of customer priorities and requirements. The participants included airlines, airports and trade organisations.

	Meeting	Date
1	Pre-consultation (WebEx)	22 Feb 2018
2	Consultation kick off	3 May 2018
3	Delivering the service	17 May 2018
4	Evolving the service	23 May 2018
5	Oceanic plan	5 Jun 2018
6	Airports engagement	6 Jun 2018
7	Additional customer requests	21 Jun 2018
8	Technical assumptions/metrics	27 Jun 2018
9	Summary/next steps	18 Jul 2018
10	Oceanic follow up	19 Jul 2018
11	Airports engagement follow up (WebEx)	25 Jul 2018
12	ADS-B business case benefits workshop	16 Aug 2018
13	RP3 resources planning workshop	23 Aug 2018
14	Consultation close	13 Sep 2018

	Airlines	Airports
1	Aer Lingus	Airport Operators Association - AOA
2	BA CityFlyer	Bristol
3	British Airways	Cardiff
4	Delta	Doncaster (Sheffield) & Durham (Tees Valley)
5	easyJet	Dublin
6	Emirates	Glasgow
7	Finnair Plc	Heathrow
8	Flybe	London Biggin Hill
9	IAG	London City
10	Jet2.com	London Gatwick
11	Loganair	London Luton
12	Qatar	London Southend
13	Saudi Arabian	London Stansted
14	TUI	Newcastle
15	Turkish	Norwich
16	United	Southampton
17	Virgin Atlantic	TAG Farnborough
18	A4E	
19	AIRE - Airlines International Representation in Europe	
20	IATA	
21	LACC	
	CAA as observers	
	DfT as attendees at some discussions on airspace	

Summary of the RP3 customer consultation on our business plan

We consulted stakeholders on our business plan for RP3 through the customer consultation working group (CCWG). The CCWG was chaired jointly, with one co-chair nominated by us and one by the airlines, and was composed of 14 airlines (including IATA) and us. Representatives from airports, the CAA, the DfT and NATS trade unions attended as observers. The consultation was governed by the CCWG terms of reference.

In total, 12 CCWG meetings and WebExs were held, with three additional workshops on the costs and benefits of oceanic ADS-B and on resources planning. We produced over 50 documents to support the process, and responded to more than 150 actions from customers, as well as more than 70 questions from the CAA.

The consultation was characterised by a lot of open debate and discussion. We received positive feedback on the consultation process from co-chairs, customers and the CAA.

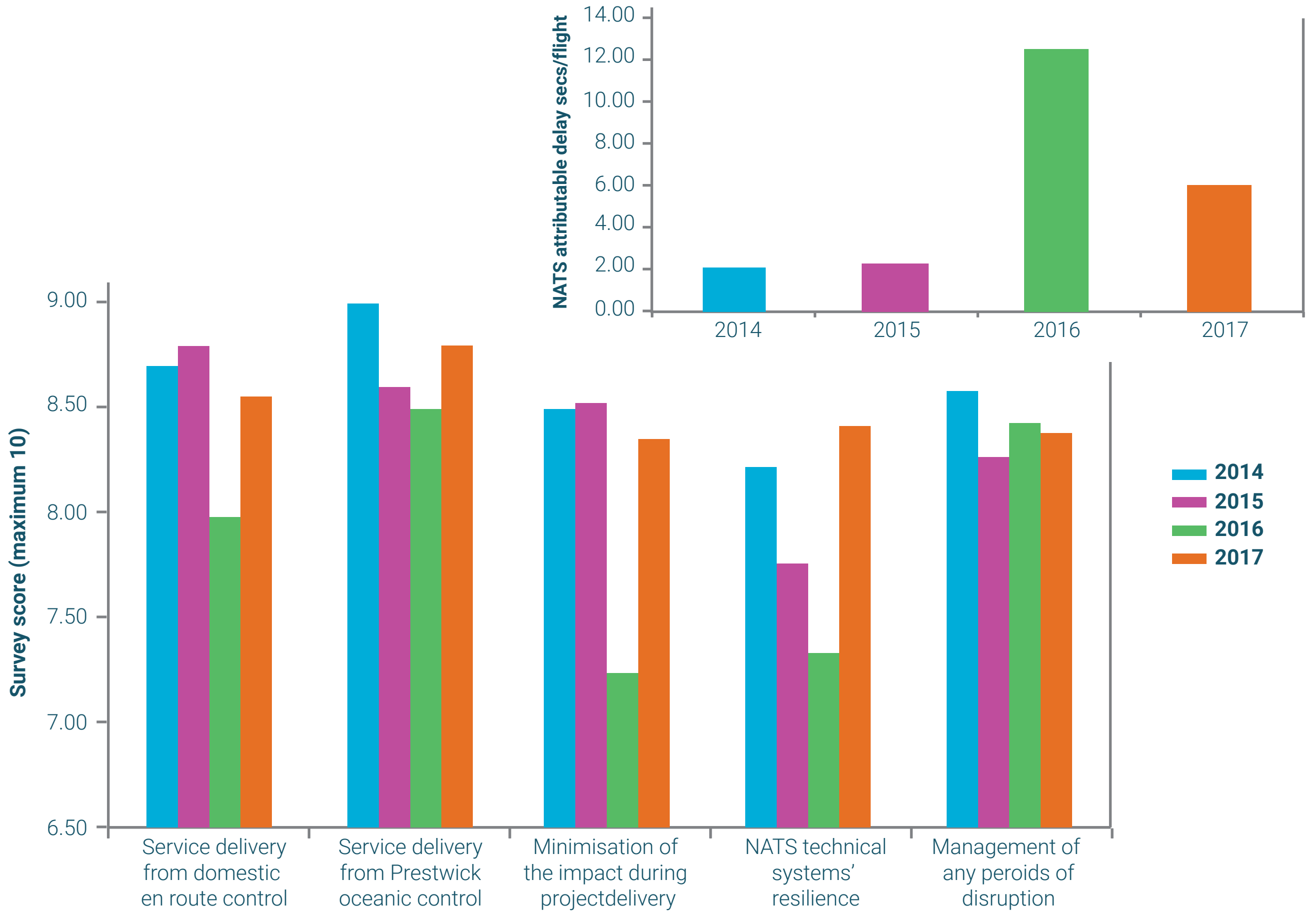
A full description of the consultation process and outcomes is set out in the report of the co-chairs.

Customer survey feedback on our operational performance

The information set out below was taken from our annual airline customer surveys and shows their feedback on our operational performance. The chart (inset) reports our average delay performance to provide relevant context.

The graphs show the survey scores from the five questions relating most closely to our operational service delivery for each calendar year from 2014 to 2017 inclusive. Over this period, the survey questions have remained consistent, enabling valid year-on-year comparisons.

Customer survey feedback on our operational performance



In most years the scores are very positive (eight or above). However, in 2016 some scores fell, reflecting higher NERL attributable delay than in other years (12.77 seconds per flight). 2016 also saw the implementation of PC Upper which, before the introduction of an enhanced overtime agreement, brought higher than predicted delays and some staffing delays.

These survey results support feedback from airlines during the RP3 customer consultation that they agree that service performance targets in RP3 should be set in line with those in RP2.

Appendix D: Safety

The European and UK regulatory KPIs and PIs

Discussions within European Aviation Safety Agency (EASA) advisory groups on performance targets have noted that there is no appetite in the industry for setting binding targets on risk reduction in RP3 i.e. to set binding targets to reduce the European risk assessment tool (RAT) score. No explicit safety targets or incentives relating to risk and severity were recommended. This was mainly because of the issues this causes for open reporting and safety culture. The advisory group focused instead on ensuring that mechanisms are in place to harmonise the management and measurement of risk across Europe. This is similar to the current RP2 regulatory requirements on the use of the RAT, maturity in safety management and just culture statements.

The safety targets outlined below describe the current understanding of the measures the European Commission (EC) is likely to set for safety in RP3. The changes necessary to enact these targets will be written by the EC into the performance implementing rule, with input from stakeholders and the Performance Review Body (PRB). Both the exact rule text and the targets will need approval from the Single Sky Committee. There is expected to be one KPI:

> Effectiveness of safety management (EoSM): This is a moderated self-assessment of the maturity of an organisation's overall safety management system. The KPI takes the form of a questionnaire covering a number of different aspects of safety management, such as safety culture, risk assessment and management of change. Since safety management capability is not directly measurable by incidents, where gaming and perverse incentives must be avoided, it is considered suitable for targeting to encourage improvement.

There are expected to be three PIs:

> Rate of accidents/serious incidents: A simple count of the numbers of accidents and serious incidents defined by the occurrence reporting rule;

> Rate of runway incursions and losses of separation (LoS): As measured using the RAT methodology for ANSPs and the European risk classification scheme at a state and EU-wide level; and

> Rate of over-delivery by the Network Manager (currently Eurocontrol): The Network Manager is required to manage the flow of traffic by sector and by route for client ANSPs. The PI is a count of the number of times this flow of traffic exceeds the threshold by more than 10%.

Once set and approved, which should be by the end of 2018, we are committed to meeting these KPIs and PIs for RP3. We will report on these measures as part of the national performance plan. Although runway incursions are outside of our remit, the CAA's Safety and Regulation Group (SARG) has previously asked us to include them in our report in the format provided by the Performance Review Body. We expect this arrangement to continue into RP3.

The UK State Safety Programme and our internal target

The UK State Safety Programme provides the criteria for an acceptable level of safety performance as required by International Civil Aviation Organisation (ICAO). This is comprised of three safety performance targets:

1. Fatal accident rate five-year rolling average in the best 5% of states;

2. Safety performance indicators track the frequency of operational events regarded as potential precursors to fatal accidents, and indicate continuous improvement in reducing these risks; and

3. Compliance with ICAO standards, recommended practices and procedures of at least 90%, with sound and considered rationale where differences have been filed.

Target 1 is a state level target and is one that the CAA is better able to monitor. We will also continue to meet target 3 and only deviate where it is shown that UK safety may otherwise be compromised.

To remain in line with target 2 of the UK State Safety Programme definition of an acceptable level of safety performance, and to continue to provide a safe service, we are setting the following high level internal safety target for RP3, in common with other safety-critical industries:

> To maintain or improve safety levels by ensuring that the number of serious or risk bearing incidents per flight does not increase, and where possible decreases.

Given our excellent historical performance this target is aspirational. It is important to recognise that targets are distinct from some defined boundary or limit for safety, and that failure to achieve or exceed an aspirational target does not mean that the safety of our services has been compromised. The primary objective is to drive the right behaviours and outcomes across the organisation. We do not want our operation to expend unnecessary effort meeting a numerical target that has no effect on improving safety.

Our strong belief is that it is counter-productive to apply enforcement and/or incentives to internal safety targets, particularly where data for these targets has to be reported by individuals. We recognise and believe that a strong reporting culture is essential for identifying safety issues, learning lessons and improvement. Incentives could drive behaviours that would be counter to this aim.

Our achievement against this target will continue to be monitored and reported. Our safety culture and commitment to delivering the target is subjected to numerous tests and challenges by our own internal review processes, along with CAA SARG regulatory oversight. We believe that the CAA SARG are fully supportive of this position.

The use of proxies for accident risk

Our safety management system sets out the processes that we follow to review and manage safety effectively. The requirement for safety monitoring allows us to identify issues so that those who need to act upon them can do so in a timely manner.

The measurement of safety, and the use of performance indicators, is generally considered to be an important element of an organisation's processes in determining the safety of its operations and the management of its risks. Performance measures are, in general, not used as ends in themselves but to enable action to be taken.

A no accident attitude to air traffic management (ATM) safety rightly prevails, but over the 60 years of civil aviation, the accident has been found to be less and less useful for measuring and assuring safety. Given the comparative rarity of aviation accidents, when compared to other safety-critical domains, and when considering the even rarer aviation accident with ATM as a contributing factor, more prevalent forms of harm have been used as measures of ATM safety.

As such, it has become typical in ATM to count proxies for the accident and to use the occurrence of these as leading indicators of safety. If there are more occurrences of proxies the natural conclusion is that the operation is less safe. The established target may reflect a historical average, an aspirational goal, or the risk appetite of the organisation. If the score deviates from the expectation or target then this is a trigger for investigation and remedial action.

Therefore, incidents are used as a proxy to assess the risk of an aircraft collision since their occurrence demonstrates a failure of the ATM process. Or, an alternative interpretation is a loss of control, which, for an air traffic control organisation, represents the most fundamental failure - of purpose.

As the rate of serious events attributable to ATM, such as Airprox, has reduced over time, there has been a need to develop more objective measures that count and assess events that are further from the accident and which occur more frequently, so providing a more statistically significant dataset.

From the mid 1990s until the formal introduction of RAT in January 2015, we used the safety significant events (SSE) scheme. Since 2015, the RAT has been used as the primary proxy for accident risk. The RAT assesses the severity and controllability of any event in which required separation is lost (other events are also within the scope of the RAT scheme).

The RAT assesses both the severity of the event, i.e. the degree to which separation was lost, and also the extent to which the incident was under control, by looking at how well the controller handled the event from detection, plan, execution and recovery. This closely aligns with a barrier model of ATM, where events that were adequately resolved by the controller in a timely manner are considered to be less severe compared to events where control was lost, and the resolution of the event relied upon pilot action or providence.

Our safety performance

During RP2 we set ourselves a challenging internal safety target based on our safety performance over CP3 (2011 to 2014). The target took into account our agreed plans for airspace development and technology change, and our commitment to continue to improve the safety of operational services. The safety target 'no increase in accident risk per flight despite increasing traffic' set out an ambitious and aspirational goal for safety performance during RP2.

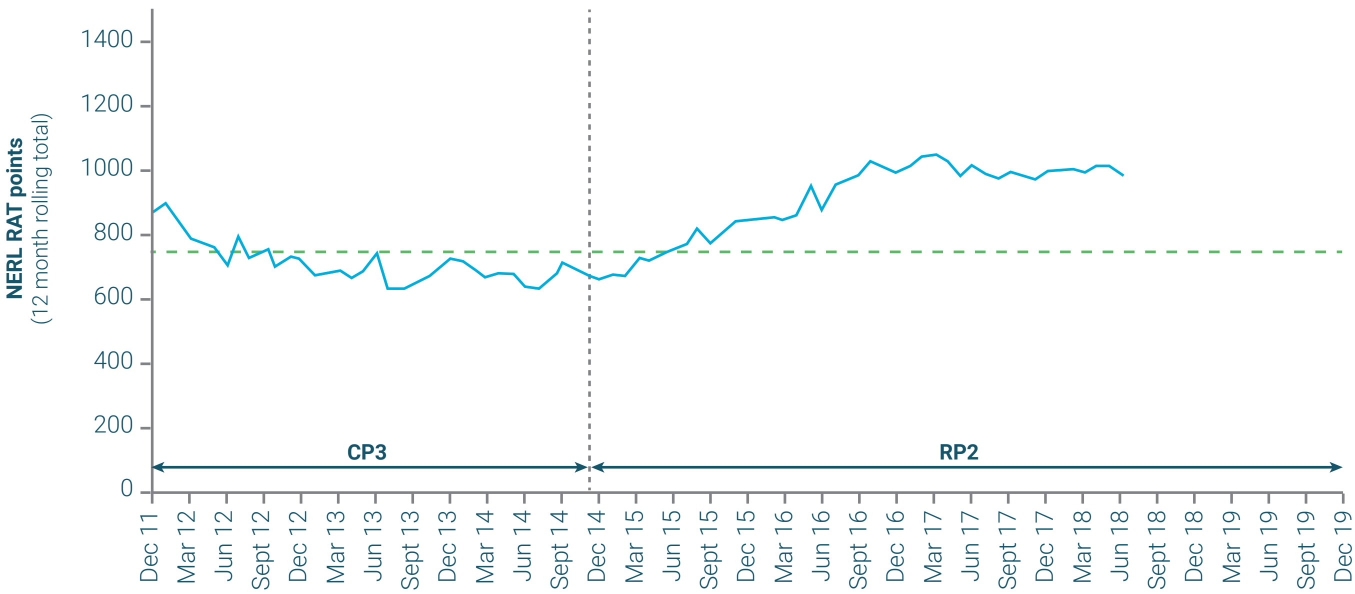
The RP2 safety target is not the first such safety target. The Destinations Programme between 2004 and 2007 set the aspirational goal of no level 1 or 2 SSEs and no category A or B Airprox where the primary causal factor was in our control. Similarly, the SESAR safety target set in 2004 can be seen as a direct challenge to the ATM industry to achieve a factor three improvement[1] in safety by 2020 (against a 70% traffic increase) with a factor of ten improvement in safety by 2030 and beyond (to support a 300% traffic increase).

Since the internal RP2 safety target was set, we have had to react to airport, public and political pressures and postpone the significant airspace changes that were planned, which were expected to deliver the majority of the expected safety improvements. This has meant a change of focus to technological change. However, these technology projects are largely of an enabling nature and are not expected to deliver substantial safety benefits until towards the end of RP3 and into RP4. Therefore, to address our internal safety target and manage the safety of the operation, we have been increasingly reliant on tactical improvements where they can be found and other short term operational protections.

For RP2, we elected to use the number of RAT points attributable to us over 12 months as the proxy measure for the accident risk, and use this to understand our safety performance. Our safety target is interpreted as being roughly equivalent to requiring a fixed level of RAT points across the regulatory control period.

Our level of performance has not tracked the fixed level of RAT points and shows an upward trend as shown in the chart below. It is unlikely that by the end of RP2 it will have improved sufficiently to meet the safety target.

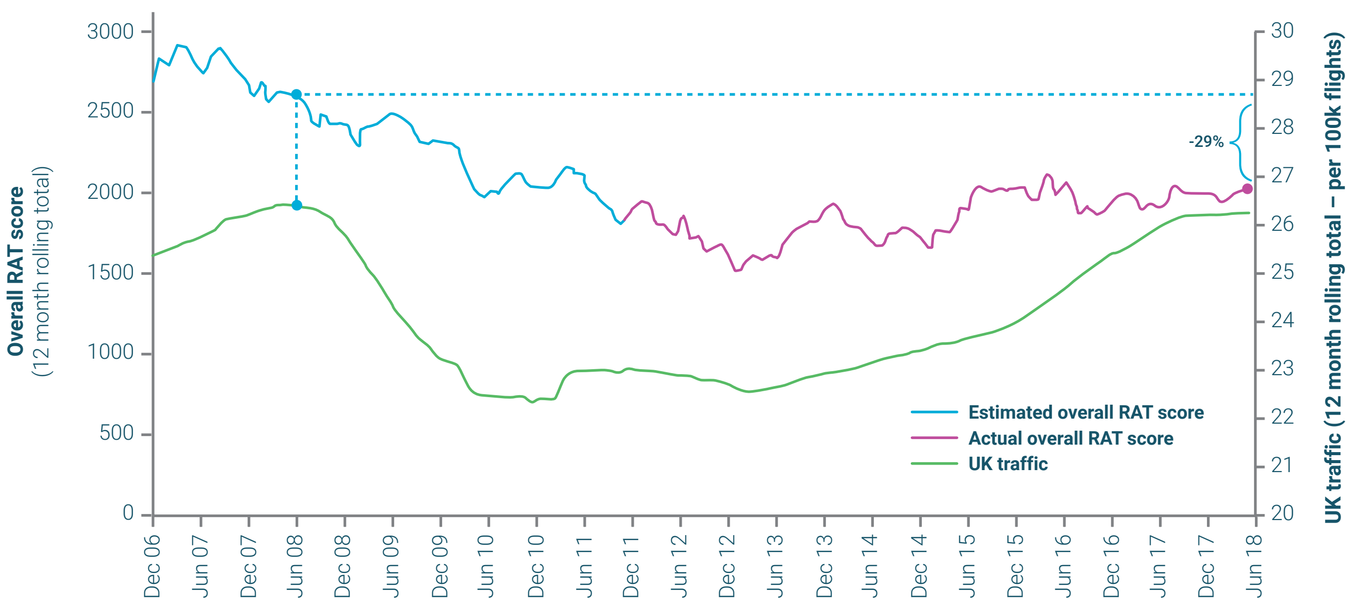
NERL RAT points to June 2018 vs safety target



2016 and 2017 were characterised by rapid growth in traffic, returning to volumes previously seen in 2007/2008. As can be seen in the chart on the next page, despite not meeting the safety target, it is estimated that outcome based safety performance is now 29% better than in 2007 with similar levels of traffic. But traffic levels above 2007/2008 levels have never been experienced before and so it is largely unknown how the ATM system will react to further traffic increases. The real challenge has been the rate of change in traffic in particular regions or sectors, rather than just the absolute number of aircraft.

[1] Improvement here means a reduction in the number of serious or risk bearing incidents.

Overall annual RAT score for incidents in our airspace



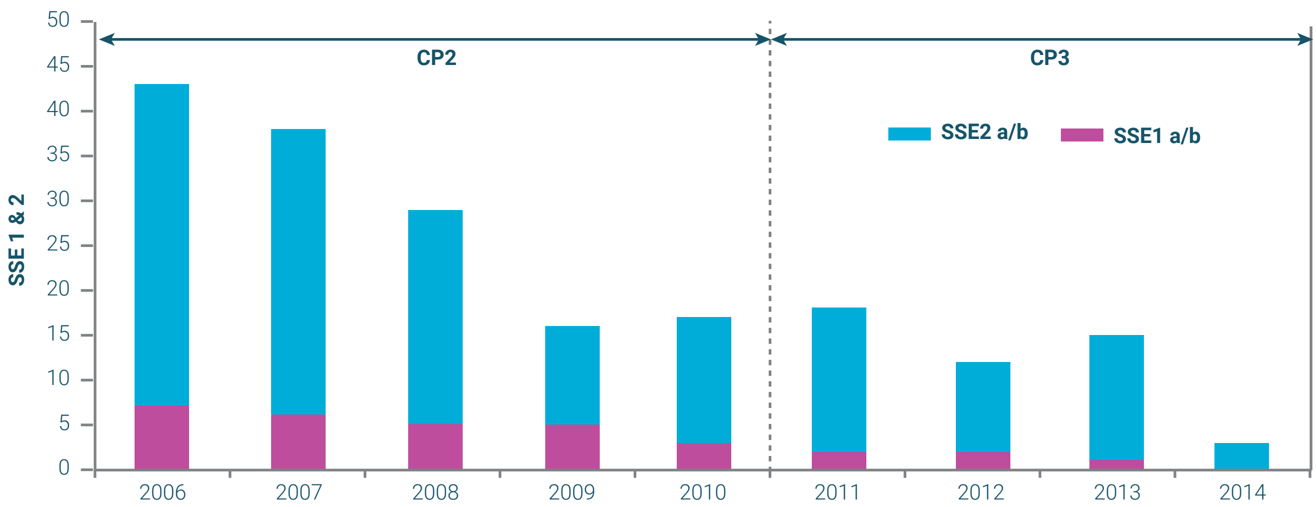
Historically, given the complexity of London terminal control (TC) and level of traffic (around 50% of all UK traffic) within a relatively small piece of airspace (~2% of total UK airspace volume), 60%-70% of all safety events and SSE or RAT points have been generated within TC. Based on these proxy measures of risk, TC has always been and continues to be the area of the operation requiring proportionately more attention.

Putting today's performance in historical context

Our current safety performance should be viewed in terms of historic performance. If past performance is believed to have been safe, or at least safe enough, then on that basis, we are still experiencing very good levels of performance. Indeed, as described earlier, given the equivalent level of traffic in 2007/2008, our safety performance using the same measures is considerably better today.

The chart below shows the old SSE scheme incident numbers. As shown, over the period of CP2 and CP3, significant progress was made in reducing the number of these incidents.

SSE 1 & 2 events between 2006 & 2014 (last year of the SSE scheme)

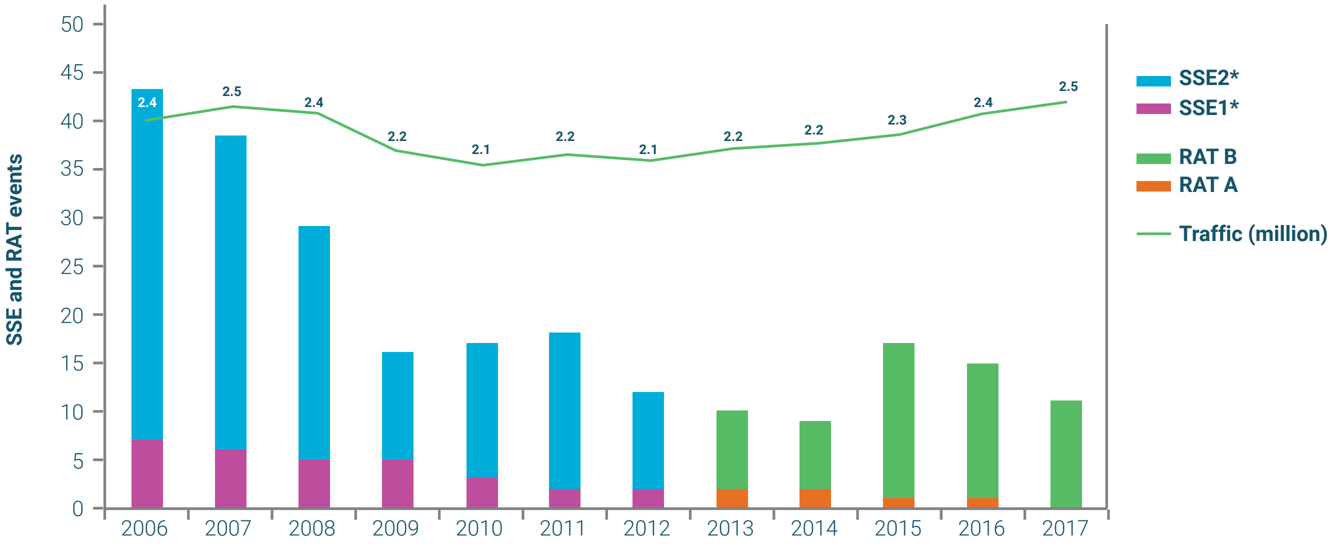


It is also worth looking at one of our previous safety targets. Set in 2004 and considered almost unattainable at the time, the 21 Destinations Programme set the aspirational goal of eliminating SSE 1 and SSE 2 events. As can be seen, this was nearly met in 2014, although the reduction in traffic will have had some impact on this as well. These high severity events are useful in making historical comparisons to today's performance.

One of the challenges in comparing historical performance is the inconsistent collection of data due to changes in the monitoring and marking schemes. However, the most serious losses of separation and incidents are still broadly counted in the same way. Although the schemes do treat them differently, SSE1 and 2 events may be indirectly compared to RAT A and B events.

The chart below replaces the SSE data with back-marked RAT data for the period where it was available. This shows a slightly different picture: one of broadly flat-lined safety performance (expressed as the severe incident count) since 2009, albeit with increasing traffic.

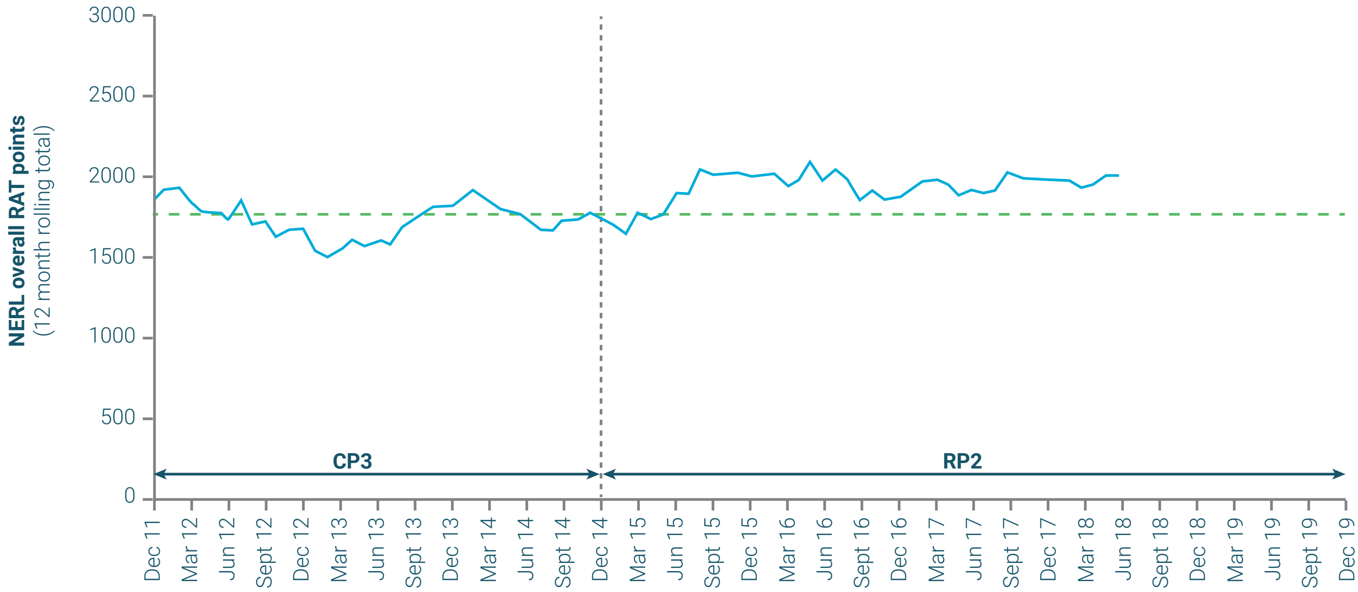
SSE 1 & 2 between 2006 and 2012 with RAT A & B events since 2013 with traffic



* Includes events that achieved less than two thirds of the required separation, i.e. SSE 1a/b or SSE 2a/b events, as these are considered to be equivalent RAT A & B events.

In keeping with the generally favourable impression of safety performance, the number of RAT A and B events in the first two years of RP2 is still substantially lower than the number of SSE 1 and 2 events at the start of CP2.

NERL overall RAT points to June 2018 vs safety target

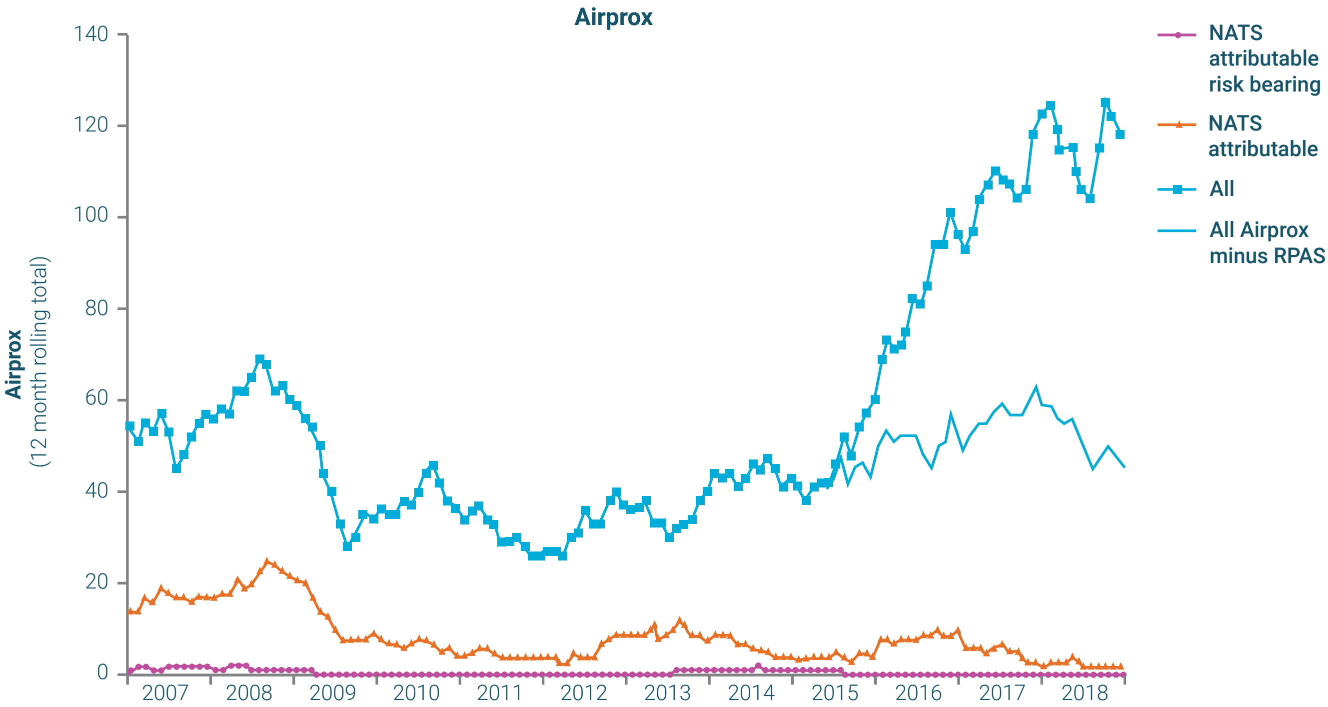


The chart on the previous page shows the overall RAT score i.e. attributions from NERL and all airspace users. The chart on page 26, shows our attributable element of this score. Based on the overall RAT view of safety risk, the total risk in our airspace is roughly constant with where it was at the end of CP3. Therefore, the actual risk (expressed in RAT score) to the travelling public is largely the same.

Given that our attributable element has increased, the stable performance may be due to improvements in the performance of other stakeholders in the airspace. It is also as a result of initiatives where we routinely act outside of our direct remit to challenge others as to the speed and rigour of safety improvement actions, for example, in addressing infringement risk (an airspace and CAA risk).

Similarly, the number of Airprox, including the number of risk bearing Airprox, attributable to us is unchanged as shown in the chart below.

Rolling 12 month Airprox statistics



The graph above shows the Airprox measure since 2007. It is a subjective, but independently assessed risk measure that is widely understood across the industry. While the Airprox measure lacks sensitivity to risk, it retains currency as a universally accepted measure of accident risk. The number of Airprox, as a class of event, in airspace where we were providing an ATC service used to number as many as 82 (in 2002) and has steadily reduced to 47 (excluding drone incidents) during 2017. The increase in Airprox drone encounters reflects, in small part, the growth of drone activity in our airspace. Drone sightings not resulting in an Airprox event have also increased steadily over time, and the true number of drone infringements into controlled airspace that go undetected remains unknown. While the increase in aircraft/drone Airprox are important, it should be noted that in general aircraft/drone Airprox do not necessarily carry the same level of risk to life that an aircraft/aircraft Airprox may.

The responsibility for ensuring the safe integration of drones in to the wider UK airspace rests with the CAA and the Department for Transport (DfT). With the number of drone incidents on the rise, we continue to engage with the CAA to educate drone hobbyists.

Partnering with a world leader in commercial drone based inspection services and training, we will also be delivering expert training to the growing commercial drone sector and the emergency services. These initiatives have the shared purpose of ensuring that both commercial and hobbyist pilots can engage in their activities safely while ensuring the safety of others.

When the attribution of cause is included, the number of Airprox where we were a causal factor is much less. For example, our attributable Airprox has reduced from around 40 per year during the period 1998 – 2004 to five in 2017. Furthermore, when these events are examined to determine whether they were risk bearing, it can be seen that since 2002 we have had less than two events a year and have not had a risk bearing Airprox attributed to us since 2014 and only three since 2008.

Meeting the RP3 safety target

Current performance

Managing increasing traffic requires an investment programme with safety benefits, coupled with continuous improvement. The exceptional traffic growth in RP2 has presented a challenge for our business. Despite being unlikely to meet our internal safety target for RP2, on other safety metrics we believe that our safety performance is either improving (for example, Airprox numbers) or stable (losses of separation). Our performance is also estimated to be 29% better than when we experienced the same amount of traffic in 2007 before the financial downturn. We are complying with, and will achieve the RP2 UK Performance Plan target for safety.

While the UK-wide traffic growth has been higher than anticipated, the growth in some UK airspace sectors has been even more pronounced. We believe that the increase in traffic, and consequent complexity, presents greater challenges, given the widely held rule that as traffic levels increase, the safety risk increases faster, exhibiting a squared or higher power relationship.

Targets

The target for safety in RP3 is described in European regulatory targets and the internal performance target set by us for RP3.

Given the relationship between the increase in incidents and the square of traffic, maintaining safety performance represents a significant challenge with increasing traffic.

Safety improvements

The Tempest model described in this plan predicts the net outcome for safety of our investments and improvement activities. It indicates that we will be able to maintain our safety performance, based on assumed traffic growth.

These combined benefits are offset by projects that may have a safety detriment. There are currently two programmes that are predicting dis-benefit: DP Voice and LAMP Enablers. In both cases they enable the future benefits from other projects, and the net benefit is expected to be positive overall. It is also worth noting that these are early, dynamic assessments, which are continually updated through the life of the programmes.

The profile of safety improvements, and resultant predicted safety performance, shown in the Tempest chart presents a pragmatic trade-off between safety, capacity and cost. The investment programme is transformational and will provide us with a platform for greater operational improvements and efficiencies in the future. The costs of the safety improvements are embedded within the wider investment programme and are not separately identifiable.

Other improvement measures

In addition to the investment programme, we manage safety risks through a combination of tactical actions as part of the day-to-day operation. Where there is a mismatch between capacity and demand, a number of tactical levers are available to manage the flow. We make every effort to apply the least penalising measure while ensuring a safe, efficient network. Regulations are applied as a last resort to preserve the safety of the network.

New entrants to our airspace

We continue to work with drone manufacturers, the regulator and drone operators to raise awareness of the risk of entering controlled airspace, and provide them with tools, within the framework of our Licence. We propose, as part of our core plan, a number of service measures to maintain safety, specifically to address the challenge from growing numbers of drones. The growing number of Airprox reports related to drones indicates that the implementation of these measures is absolutely required to maintain safety levels.

Proposed internal KPIs for RP3

Given our historical performance and our better understanding of the RAT methodology, more useful performance indicators can be derived. To monitor our progress in meeting our internal safety target 'to maintain or improve safety levels by ensuring that the number of serious or risk bearing incidents per flight does not increase and where possible decreases', we propose the following five KPIs.

Proposed internal KPIs for RP3

Continue to set a target against A and B Airprox attributable to us – Zero A or B risk bearing Airprox attributable to us
Count the number of our A and B RAT events – Maintain or reduce the number of our RAT A and B events
Count the number of losses of separation (LoS) per 100k movements – Maintain or reduce the number of LoS per 100k movements attributable to us
Measure our RAT score per 100k movements (split between controllability and severity) – Maintain or reduce the RAT controllability points per 100k movements – Maintain or reduce the RAT severity points per 100k movements
Measure our overall RAT score – Maintain or reduce the overall RAT points per 100k movements

In addition to these five KPIs, we will continue to monitor and address many other performance indicators throughout the RP3 period. These include:

> Workload measures;

> Hot spots;

> Traffic collision avoidance system events;

> Short term conflict alert and barometric pressure setting tool;

> Danger area infringements and wake vortex turbulence encounters; and

> Data gathered through safety audits or day-to-day safety observations.

KPIs are measures or counts of different safety events that demonstrate an increase, decrease or trend in order to determine what action is necessary. However, it is important to recognise that these rely on a just reporting and learning culture, significant investigation and collaboration with many stakeholders, internally and externally. All of these back-room activities should not be forgotten or taken for granted, and are also regularly monitored.

Benchmarking and international bi-lateral activities

Our goal is to operate at the forefront of safety management so that we are in a position of strength and understanding. To support this goal, we have excellent working relationships across the ATM industry, both in Europe and globally. We achieve this through bi-lateral arrangements and our leadership in the Civil Air Navigation Services Organisation (CANSO), which allows us to influence and, in many cases, lead on the development of safety management in the industry. CANSO is the global voice of air traffic management and was founded to represent the interests of the ANSPs worldwide. CANSO represents members' views in major regulatory and industry forums, including at ICAO, where it has official observer status.

CANSO brings together the ANSP community with the aim of improving global ATM performance. This is achieved by sharing best practices and case studies, measuring performance, setting benchmarks and targets, and developing practical tools for ANSP managers. We are a leading member in the safety activities of both CANSO Europe and CANSO Global. CANSO's safety work programme helps ANSPs improve safety through elements such as safety management systems and benchmarking.

Our engagement in CANSO Europe specifically supports objectives to influence ICAO and wider industry through development of CANSO Safety Strategy and Implementation Plan, collaborate with other service providers to build common positions in preparation for safety meetings with ICAO, EC, European Aviation Safety Agency and Eurocontrol and to influence future rules and regulation as appropriate.

In CANSO Global, our influence extends to the safety management maturity questionnaire and CANSO's standard of excellence in ANS safety assessments and to undertake comparability analyses between global ANSPs looking to share best practices and understand the differences in their operations.

Particularly through our international engagement in CANSO, as well as on a bi-lateral basis, we have sought to benchmark ourselves against our peer organisations to ensure that we are continuing to adopt industry best practices and have comparable safety performance. Through these relationships we believe that we remain at the forefront of industry thinking when it comes to safety management and risk measurement, and that our safety performance is at the top end of the rankings compared to similar ANSPs.

Appendix E: Capacity

This appendix describes our proposed approach to the capacity metrics for RP3.

Structure of metrics

We propose to retain the current service quality metrics (C1, C2, C3 and C4)[1], as they drive the right operational decisions to benefit customers, for example, minimising delay in peak hours. During the RP3 customer consultation, customers indicated their support for this approach.

The metrics are well understood by our customers, the CAA and us. They are also consistent with the current European performance framework.

However, we propose that we should make a number of modifications to the way metrics are reported and used to set incentive schemes:

1) Capacity metrics should be reported at national level, rather than at a functional airspace block (FAB) level, to improve visibility of where delays in the network are generated. In our view, the FAB dimension to the current C1 metric does not add value, and in fact makes the performance regime less transparent. Current indications suggest that the RP3 European framework will support this, with removal of FAB level reporting requirements.

2) It is not appropriate for us to be held accountable for delivering targets outside our control. Therefore, we propose that the 'all delay codes average minutes of en route air traffic flow management (ATFM) delay per flight' metric (i.e. the C1 metric) should be retained as a performance indicator only, for monitoring and reporting purposes, and should not be used for setting incentives. During the RP3 customer consultation, customers stated that C1 has limited value, while the other metrics were more relevant.

We recognise that the incentive scheme is likely to need to be consistent with European regulations, so the proposal above is dependent upon the regulatory requirements that will apply in RP3.

The latest draft regulation for RP3 (published August 2018) would impose mandatory asymmetric capacity incentive schemes. Either the C1 or C2 metric could be used as the basis. If adopted, 3% of determined costs would be at risk through penalties, while ANSPs would have the possibility of earning a maximum 1% of determined costs bonus. We do not believe that this asymmetrical treatment is merited and the resulting change in risk exposure compared to the RP2 schemes would have a corresponding effect on our cost of capital (see Appendix P). In addition, the draft regulation permits additional local incentive schemes, so that financial incentives on C3 and/or C4 could be maintained. However, given the material proportion of determined costs that would be at risk under the mandatory incentive schemes, customers confirmed that they would have no appetite for additional local incentive schemes because this would only add risk to the UK performance scheme, which would already have significantly greater risk than in RP2.

See Appendix O for further details on the incentive scheme.

Calculation of metrics

We propose to maintain the current calculation methodology for each of the metrics. However, bearing in mind that the metrics are used to determine financial incentives/penalties, it is critical that metrics are calculated using reliable and accurate data (adjusted via the Network Manager's post-operations adjustment process). We will request that such adjustments are made in the Network Manager's forums, to agree adjustments to reported delay in a more timely manner than the current process. We would appreciate support from customers and the CAA for this.

In addition, we consider that airport collaborative decision-making related delay should be removed from all delay metrics as this is not attributable to air navigation service providers (ANSP). The Network Manager is supportive since the delay results from the interaction between the operation of systems by the Network Manager and airports, and is not generated by the ANSP.

[1] Including current traffic modulation and deadband features of the performance regime.

Special event transition delay allowance

In RP2, the concept of exemption days was introduced to the capacity metrics. The purpose of the exemption days was to prevent us being penalised for planned airspace and technical transitions that had been consulted on with customers. Through this mechanism, selected transition days are exempt from financial penalty under the C3 (weighted delay term) or C4 (variability term), whichever is the higher penalty. Delays in the C2 (average NERL attributable delay per flight) term are not subject to exemptions.

In RP2, the CAA allocated a maximum of 75 exemption days across the whole reference period for declared notified transitions. For example, for the second ExCDS transition into limited operational service, we declared a three-week transition period, and planned to use three exemption days within that period. On all other days, any delay due to the transition counted towards C3 and C4.

We believe that the exemption days mechanism could be improved because:

> Transition delays appear in the headline performance metrics, inflating the annually reported values and associated targets, and making it more difficult to understand the true network capacity and resilience target that we are aiming for; and

> Exemptions are a blunt tool as all delays on selected days are exempt, even if some delays were not generated by the transition event.

Therefore, we are proposing to replace the exemption days with a special event transition delay allowance in RP3, which would operate as follows:

> Par values for C1, C2, C3 and C4 would be set at a level that excludes special event delays due to certain pre-identified large, complex planned transitions - DP En Route, DP Lower and London Airspace Management Programme (LAMP). The resulting headline delay metrics would therefore provide a better representation of the expected level of our daily operational performance;

> Special event delays due to other smaller transitions would continue to be reflected in the C2 and C3 metrics and targets as is the case today. No changes would be required to the metrics and the financial incentive mechanism, maintaining transparency;

> The special event transition delay allowance would be used following consultation with our customers (much like the exemption days) prior to transitions for DP En Route, DP Lower and LAMP. The special event transition delay allowance would not be used for smaller transitions;

> Delays allocated to the special event transition delay allowance would not be counted within the capacity metrics, unless the actual delays within the transition exceed the consulted and agreed delay profile for the transition;

> To avoid double jeopardy, special event delays for planned transitions would not be counted in the C4 variability term; and

> Unused delay allowance (where the transition creates less delay than agreed) would not be carried over for later transitions.

The special event transition delay is intended to encourage customers and us to work together to manage the large scale transitions. We propose that, prior to each transition, the delay allowance should be agreed with customers through the Service and Investment Plan (SIP) process, operational partnership agreement (OPA) and via bespoke consultation. Allowances should provide sufficient flexibility, as well as challenge us to deliver effective transitions. Allowances for DP En Route, DP Lower and LAMP will be set as part of the customer consultation process, no later than three weeks before the start of each transition. The transition period and delay allowance may include training and transition.

If we are not able to agree a suitable allowance ahead of each transition with customers, we suggest the CAA should set an appropriate allowance. We will report back to customers and the CAA on the planned transitions and delay allowance via the Condition 11 report, and report directly to customers as we did for ExCDS.

Experience demonstrates how we have delivered efficient transitions in the past. The delay generated by recent major transitions is shown in the table below.

Delay generated by recent major transitions

Transition	Transition delay generated	Year
ExCDS	Estimated: 220,000 mins[2]	2017/2018
LAMP Phase 1	45,722 mins	2016
PC Upper	106,654 mins	2016
iFACTS	41,000 mins (excluding staffing delays due to training)	2012

[2] Original planning estimate was 280,000 minutes.

In comparison, other European ANSPs have generated the following levels of delay for transitions of a similar scale:

> The German ANSP, DFS, generated 1,600,000 minutes of delay during implementation of VAFORIT (equivalent to our iTEC) in German upper airspace at Karlsruhe;

> The French ANSP, DSNA, generated 450,000 minutes of delay at Brest ACC during implementation of ERATO (equivalent of ExCDS); and

> DFS generated 70,000 minutes of delay at Langen ACC for implementation of P2 PSS (electronic flight strips).

High level planning currently indicates that the special event transition delay allowance should permit approximately 400,000 minutes for the DP En Route transition.

We are unable to provide estimates for DP Lower and LAMP at this stage, and will consult customers in RP3 using the mechanism proposed above.

London Approach

We have considered whether there should be separate targets for London Approach. However, segmenting different parts of the network in this way is not consistent with the Licence requirement described above, and we believe it could drive the wrong behaviours and lead to the wrong outcomes for the travelling public.

Such an approach is likely to result in an understandable desire by stakeholders for a continuous analysis cycle of the individual actions taken by experts who are trained to manage the network as a whole. We believe this will inevitably lead to lobbying for optimisation of one part of the network at the expense of other parts, potentially benefitting some customers while adversely affecting others. It could also produce a sub-optimal result for network efficiency overall. Customer feedback from the RP3 customer consultation supports maintaining the status quo, retaining data but not setting separate targets.

Given this, we believe that establishing separate targets for London Approach specifically would add cost, distract from delivering the best service for the network and potentially result in unfair outcomes to the travelling public.

As part of the work to develop our reporting on service performance and standards under Condition 11 of our Licence, we will consult with our customers on some additional reporting measures specific to our performance in London Approach sectors, building on the existing Oberon reporting data in Condition 11 including:

> The availability of our service for London Approach airports;

> Scheduled demand per hour compared to actual demand per hour; and

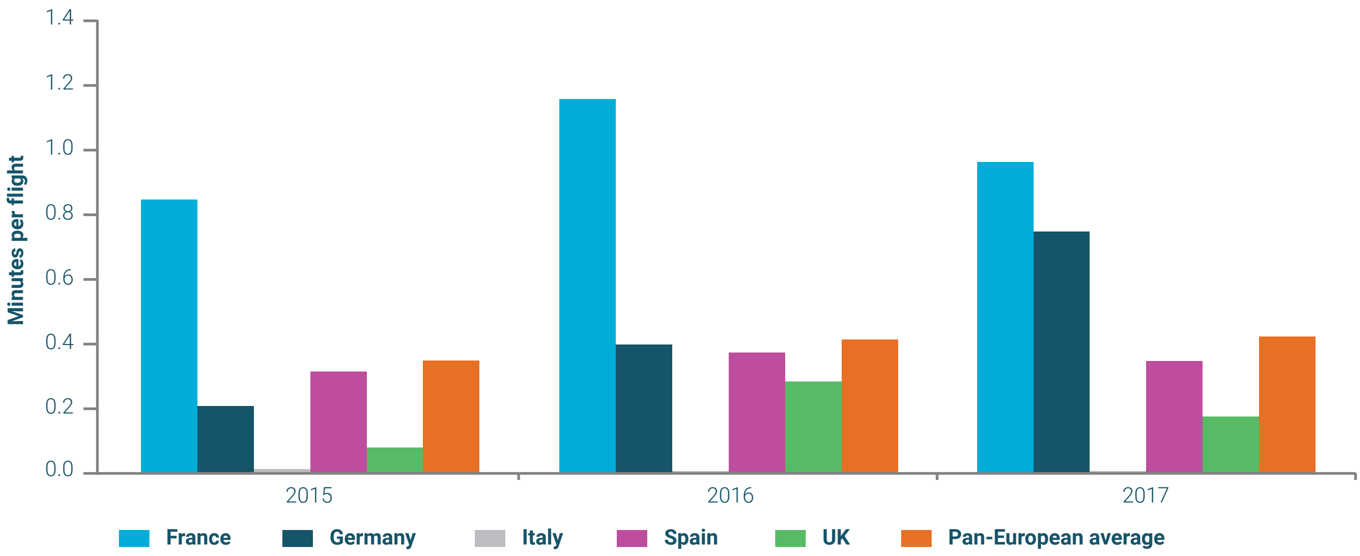
> Traffic growth per airport compared with agreed forecast.

Appendix F: Impact of ATM on airline costs

The Performance Review Unit[1] (PRU) within Eurocontrol estimates that every second of air traffic flow and capacity management (ATFM) measured as average delay per flight in the UK adds over £4m[2] to airline operating costs. Given the significance of this, we place great emphasis on ensuring that delays caused by air traffic control are mitigated as far as is practical.

The chart below shows that, in 2017, our delay performance compared extremely favourably against other large air navigation service providers (ANSP) and the average en route delay across Europe as a whole. In RP2, the UK average en route ATFM delay per flight has consistently been the fourth lowest of the big five ANSPs and below the pan-European average (of the 41 Eurocontrol member states).

Average en route ATFM delay per flight (minutes per flight)



Source: EUROCONTROL PRU

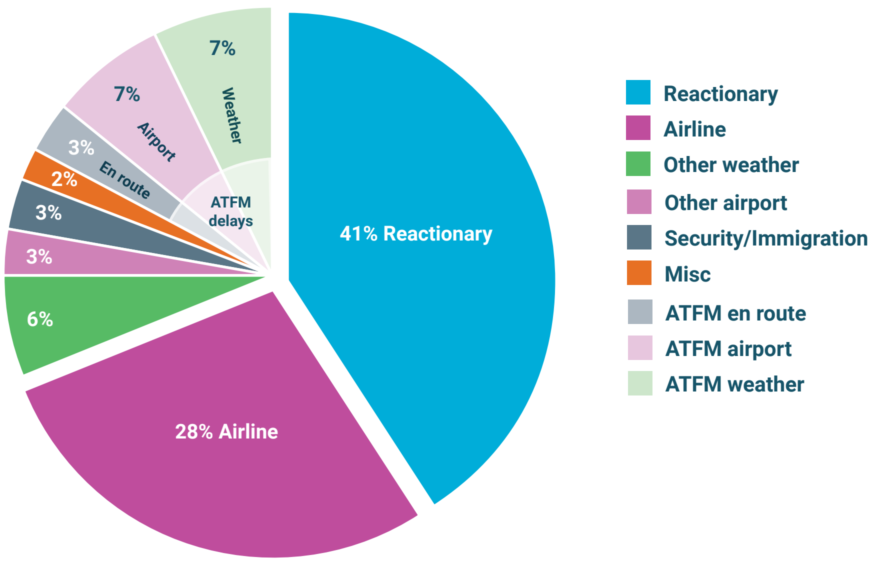
Delays caused by air traffic control have only formed a small part of the overall delay picture in recent years. The element of ATFM delay to en route caused by us is even smaller. Nonetheless, when all types of airline delays are considered, the impact of air traffic management (ATM) related delay on airlines is very significant – it is estimated to be in excess of £450m p.a. in the UK in 2017 (see bar chart 'Airline delay related costs in the UK for 2017' below). Although many of these delays are outside our direct control, our investments and those by airports can influence these delays, and our business plan contains resources to work with other partners to do so.

Airline delays in Europe – a breakdown

According to CODA[3] data, which covers Europe as a whole, primary air traffic en route delays in Europe represented approximately 3% of total airline delays in 2016, as shown in the chart at the top of the next page. Total primary ATFM delay, including weather and airport cause codes, represented 17% of total airline delays and would also have added to reactionary[4] delays.

[1] The PRU carries out work on behalf of the Performance Review Commission, which provides advice to Eurocontrol's governing bodies on European ATM performance.
[2] This is based on University of Westminster delay cost of €91 per minute of delay (2009 prices). With 2.5m flights each second of average delay per flight equates to c. 42,000 mins delay. At Euro exchange rate of £1 = €1.15, and updated for inflation, this equals c. £4.2m per second.
[3] Central Office of Delay Analysis (CODA) airline delay reporting.
[4] Data is not available to determine the effect on reactionary delay but it is recognised that first wave delays can multiply the delay impact by two to three times for short haul multiple rotations. Hence primary delay figures under-estimate the cost of delays to airlines. This is recognised in the C3 delay term which heavily weights long first wave delays.

CODA European airline delays 2016

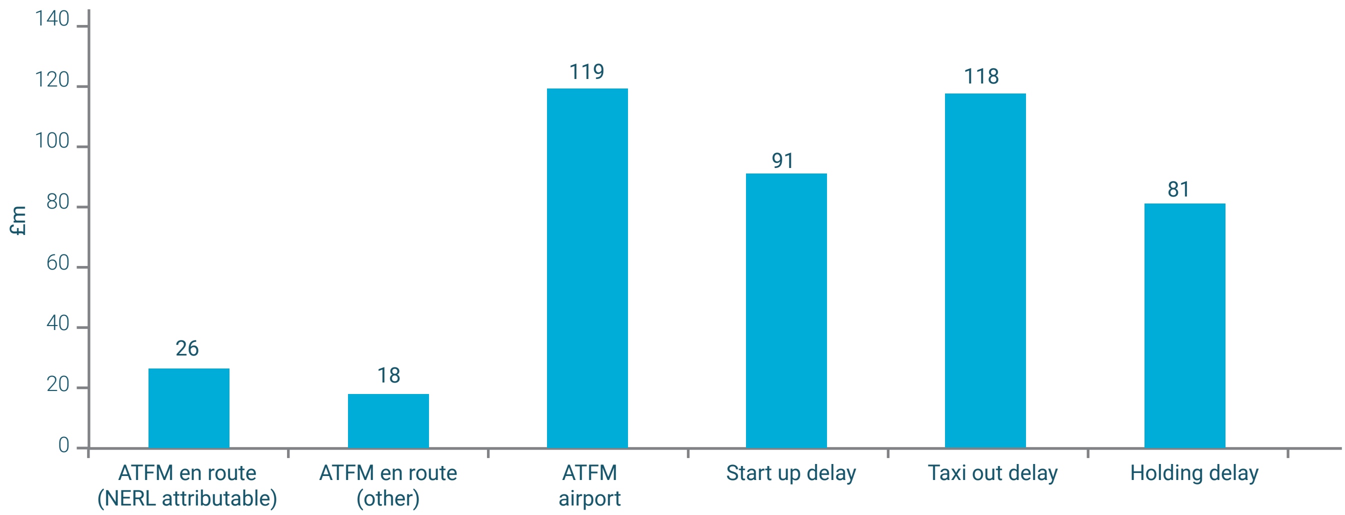


Airline delays in the UK – a breakdown

Turning to the UK, the chart below shows that ATFM en route delay in 2017 represented a small part of the overall delay picture. As illustrated below, total airline delay costs are estimated at more than £450m p.a., of which only £26m (around 6%) relates to ATFM en route delays that are attributable to us.

The impact of ATFM airport delay, start up delay, excess taxi time[5] and airborne holding[6] are far more significant in terms of airline operating costs. While these other delay causes are outside of our direct control, our investments in airspace and technology can, for example, help to reduce start up and taxi out time inefficiencies by reducing the level of standard instrument departure, short term ATFCM measures and terminal manoeuvring area congestion delay through the implementation of queue/network management tools and techniques. We can also help to optimise airspace design in conjunction with airport-led changes to low level airspace designs, co-ordinated through the CAA's Future Airspace Strategy Implementation (FASI) North and FASI South.

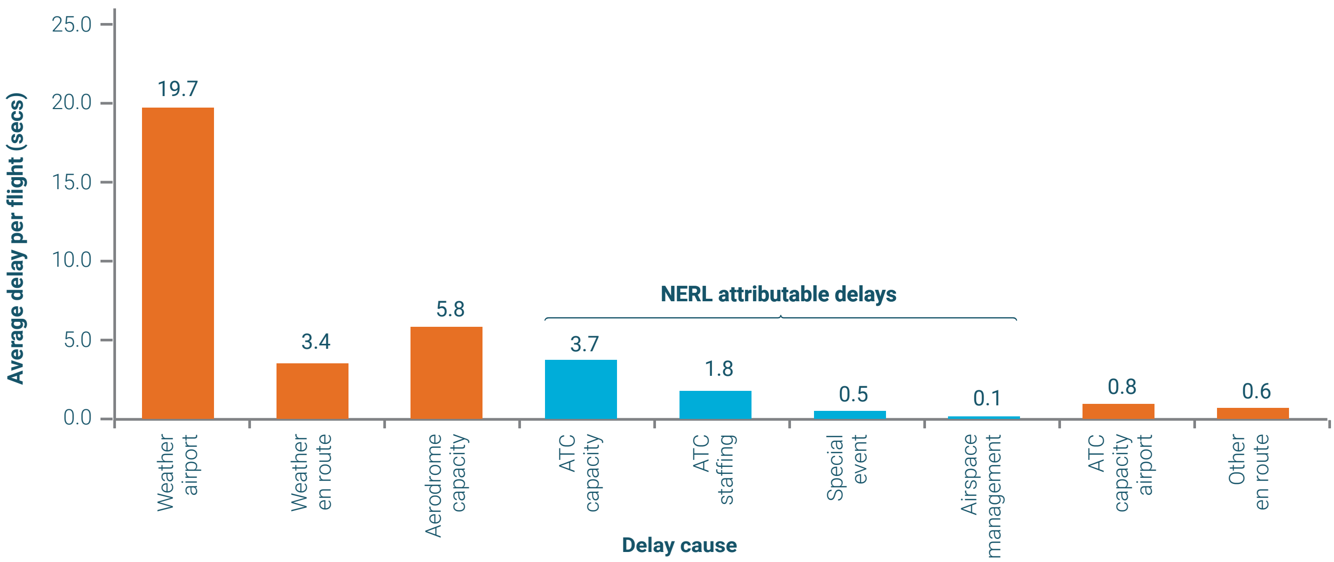
Airline delay related costs in the UK[7]



[5] Start up and taxi delays are taken from Performance Review Report (PRR) 2016 and are rounded down. Heathrow start up delay data was provided by HAL.
[6] Holding data from April 2017 is replaced by congestion delay which includes an element of path stretching so it is a more complete measure.
[7] ATFM and holding delays - source NERL 2017; start up and taxi out delays derived from PRR 2016 data supplemented by data provided by HAL.

Turning to ATFM delays only, the chart below breaks down the UK ATFM delays in greater detail, displaying the value in the average number of seconds delay per flight. The cost of en route ATFM delay attributable to us, valued at £26m p.a. in the chart above, is shown with the blue bars, and was around six seconds per flight in 2017. ATFM delays relating to weather represent the most significant elements of UK ATFM delay.

UK average ATFM delay per flight by cause for 2017



Putting a value on the cost of delay

We have used PRU valuation techniques to estimate the cost of delay to airlines in this document. The values used for this analysis are taken from Performance Review Report (PRR 2015[8]), which itself draws on the latest University of Westminster report[9].

In valuing delay costs, the PRR 2015 distinguishes between tactical and strategic delays, recognising that the cost to airlines of different types of delay will vary depending on factors such as the predictability of that delay:

> Tactical delays: Occur infrequently and are therefore difficult for airlines to predict during the scheduling phase. While the fuel burn is quasi nil, the impact on airlines' schedules is significant. Due to the lower level of predictability and resulting passenger related cost (compensation, rebooking, etc.) and network related cost (reactionary delay), the cost of one minute of tactical delay is considered to be higher than for strategic delay (excluding fuel burn); and

> Strategic delays: Although not entirely predictable, a large share of the time inefficiencies experienced every day in the gate-to-gate phase (taxi out, en route, terminal holdings) is already embedded in the scheduled block times, which limits the impact on punctuality and associated costs.

Values in PRR 2015 are quoted in euros and in 2009 prices. Adjustments have been made to update the values for cumulative CPI inflation (an increase of 26%) and to convert to sterling at a rate of £1 = €1.15.

[8] The Performance Review Report (2016) does not refer to the value of non ATFM delays as it focuses mainly on the ATFM element. For this reason, the values and methodology within PRR 2015 have been used. Values have been uplifted for inflation.
[9] University of Westminster, (European Airline Delay Cost Reference Values - Updated and Extended Values - Final Report (Version 4.1)), December 2015.

Types and costs of delays

Delay type	PRR category	Cost value	Cost areas captured
ATFCM delay (all types) and start up delay	Tactical	€91/min (2009 prices) = £100/min (2017 prices)	Crew costs, maintenance costs and passenger compensation costs, re-booking/opportunity costs. Note - Passenger value of time is not included.
Holding delay and additional taxi out time	Strategic	€27/min (2009 prices) = £30/min (2017 prices)	Crew costs, maintenance costs and aircraft ownership. Note - the fuel cost element relating to airborne holding is not included within this analysis of delay costs, as it is captured within NERL's 3Di metric.

When assessing the benefit of individual business cases, we make a distinction between delays of greater than and less than 15 minutes and also adjust to take into account the mix of aircraft which use UK airspace.

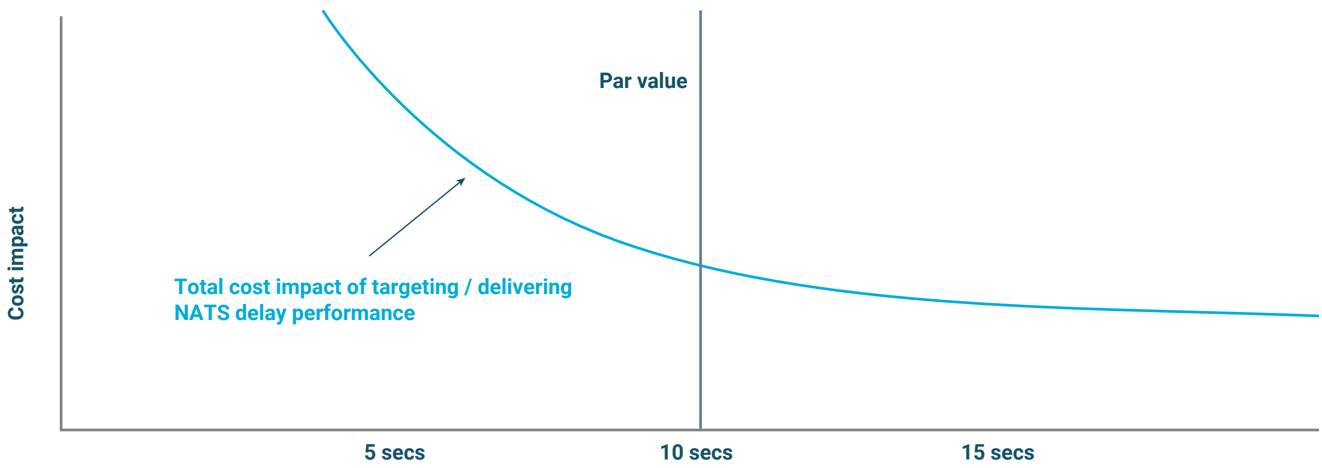
Our approach to delay

We, and our customers, have a strategic interest in ensuring that there is sufficient air traffic control capacity to cater for traffic growth and changes to demand profiles and routings. The costs of delay to airlines far outweigh the marginal cost of catering for it. These delays can result from factors such as failing to cater for high case traffic, being unable to manage unexpected changes in the profile of demand, or having to deal with changes in traffic volumes within particular geographical sectors in our airspace, which can lead to capacity constraints.

Our plan assumes that we will be able to make the investments proposed in this business plan to keep delays that are attributable to us within similar target levels to those in RP2. This will be particularly challenging as traffic grows across the control period. For this reason, investments in both technology and airspace modernisation are required to provide the capacity for this increased traffic, and avoid significant growth in en route ATFM delay, for which we are responsible.

We do not believe that setting more stretching regulatory targets on average delay per flight in RP3 is cost effective, as it would require significant additional investment and operating cost, and would only result in a relatively small improvement in overall ATM delays. This is illustrated in the chart below.

Trade-off between cost and average delay per flight



In addition, our plan contains resources which will allow us to work with other partners to influence the much more significant delays that are not within our direct responsibility. For example:

> Investment in airspace change, including departure routes at low level[10], can provide mitigation for taxi time and start up delays by increasing departure capacity;

> Airport ATFM delays and airborne holding[11] can also be reduced by increased arrival capacity, which is enabled by investment in independent parallel approach and enhancements, and further roll-out of time based and pairwise separation[12]; and

> The delay and fuel cost of arrival airborne holding can also in part be mitigated by further deployment of arrival management.

Airport weather delays remain the single highest cause of ATFM delay. Provision of enhanced Met information to all stakeholders including airlines, airports and us enables better collaborative decision-making. Met data is provided by the UK Met Office.

These enhancements should be funded through the UK Met Office's component of the unit rate for RP3.

Delivering consistent daily operational performance

Our plan addresses our customers' priority to provide a resilient, predictable and consistent daily operational service. In addition, we have taken on board the expectations from the CAA's guidance and recommendations of the Oberon enquiry.

Our proposed service quality targets reflect forecast traffic growth and the staffing, technology and airspace changes in our plan. The targets assume that we continue to maintain a positive employee relations climate, with flexibility from our operational workforce. If any of these elements change, then the service performance outcomes will vary.

Increased operational staffing is required to support the delivery of our technology and airspace change programmes, and to help minimise the impact of technical and airspace transitions. Without the level of operational resilience that our plan delivers, there will be more days with staffing delay spikes (for example, due to sickness) which would result in flight cancellations and higher than average delays.

During periods of training and transition for the major technology and airspace programmes, there will be more controllers involved in training and fewer controllers available to maintain the day-to-day operation and, therefore, lower operational resilience. If the controller numbers are lower than our plan levels this will result in more days when delays are above daily or seasonal average, and with the potential for flight cancellations and significant disruption to passengers.

The table below sets out the C2 score (average delay per flight) that we believe our plan will deliver. Also shown are sensitivities for how C2 scores would change with fewer staff and without planned airspace changes.

Sensitivity of C2 score to plan scenarios

Scenario	Characteristics	C2 score in 2024
Our plan	Staffing and investment based on our core plan	11.3
Scenario 1	Reducing the scope of our plan to exclude our proposed airspace change programme	18.4
Scenario 2	Reducing staffing in our plan by 50 ATCOs	17.9
Scenario 3 (scenarios 1+2)	Reducing staffing in our plan by 50 ATCOs and excluding our proposed airspace change programme	26.6

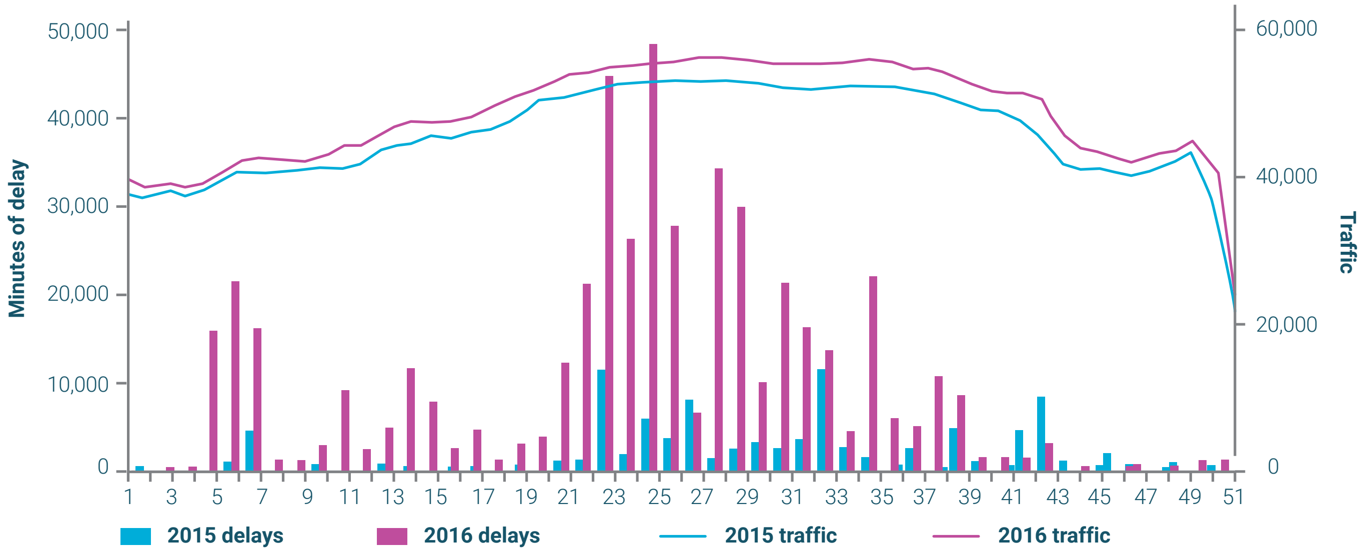
The information in the table shows that compared to our plan, C2 delay would worsen by around seven seconds if ATCO numbers were reduced by 50 or if we had insufficient staff to deliver our proposed airspace change programme. This would worsen by a further eight to nine seconds if both these scenarios occurred. The impact of reduced staffing would not be evenly spread across the year and delay arising from, for example, short notice sickness, would not be spread evenly across the network but would likely be concentrated on specific sectors or airports. It would most likely manifest itself as an increasing number of days with delays of 5,000 - 10,000 minutes or more, as a result of the reduced resilience. Such delays would increase as traffic grows and could occur on 30 days or more a year.

[10] In the UK, arrival and departure routes below 4,000ft - 7,000ft are the responsibility of airports but changes require investment in the en route.
[11] Airborne holding primarily results from schedule and factors such as airfield weather, but investments including arrival management and time based separation (TBS) can reduce holding.
[12] The first phase of time based separation went live at Heathrow in March 2015 and holding delays have reduced by 115,000 minutes since it went live. In addition, ATFM delays due to strong headwinds have reduced by approximately 60%.

As staffing shortages (for example, due to sickness) affect specific skills on a given day, the delay impact could affect particular airports and airlines more than others, rather than being spread uniformly across all airports and airlines.

An illustration of these effects is set out in the chart below, which shows C2 delay and traffic levels in 2015 and 2016. This has been taken from our Condition 11 reports. During 2016, we had lower operational resilience when traffic increased more rapidly than the staffing levels required to handle this traffic. This was exacerbated by the low take up of voluntary overtime and delivery of PC Upper into the operation. As a result, our 2016 operational performance was affected to a greater extent by the transitions for PC Upper and LAMP 1A, resulting in more days with higher than average delay.

NERL attributable C2 delay and traffic levels in 2015 and 2016



Appendix G: Environment

We propose that we should continue to use the 3Di model in RP3 as a proxy measure for fuel burn efficiency in UK domestic airspace, based on civil flight movements. 3Di uses empirical radar data to compare the efficiency of actual flights against theoretical profiles, which aim to minimise fuel burn. It also allows annual performance targets to be set that take account of past performance levels, expected operational improvements and wider industry change.

However, the CAA have invited us to propose modifications to the 3Di model, drawing out factors that could have a significant impact on performance and taking account of improvements in data.

When 3Di was originally agreed with our customers and the CAA in 2012, it was underpinned by a set of criteria, including a key requirement that the metric should not be unduly affected by factors beyond our control. Experience during RP2 has shown that the 3Di score has been affected by factors outside of our control. These include:

- Airport operator and airline actions, including: airport schedules and scheduled arrival holding, airport growth, capacity or delay priorities and choice of minimum cost routes, all of which often lead to negative outcomes for fuel efficiency. For example, we have seen disproportionate increases in 3Di at constrained airports, affecting fuel burn and emissions (3Di);
- Inclusion of flight data for aircraft not under our control. During RP2 a change to air traffic control technology meant that flight profile data from aircraft under another air navigation service provider's (ANSP) control became visible to us and so was incorporated within the 3Di score; and
- Operational factors such as mass diversion scenarios, runway direction, weather and positioning/training flights. In each case we have limited control on the efficiency of the flight and we are either responding to the need to safely manage airspace or are delivering a service to flights that are trying to achieve a different objective to fuel efficiency. For example, calibration, surveillance and training flights are not always aiming to fly direct, fuel efficient profiles.

We propose that the refinements below are made to the current 3Di metric. This will ensure that it remains focused on delivering airspace efficiency in areas where we have control, while still realising the fuel burn and emissions benefits that our customers value so highly.

We recognise that the incentive scheme is likely to be consistent with European regulations, therefore, the proposal above is dependent upon the regulatory requirements which will apply in RP3.

The latest draft regulation for RP3 (published August 2018) permits optional incentive schemes on environment metrics. The schemes are symmetric, with the possibility of a maximum bonus/penalty of 1% of determined costs. If adopted, member states would have discretion to base the scheme on the European KEA (horizontal flight efficiency) metric or an alternative.

Discussions during the RP3 customer consultation indicated that airlines were strongly supportive of our proposal to continue to use an incentivised, refined 3Di metric to target fuel efficiency rather than KEA. This was on the basis that:

- Airlines recognised the success of the 3Di metric as driving the need for fuel efficiency in our operations since its introduction in 2012;
- The scope of the 3Di metric is greater than KEA and therefore incentivises us to deliver more benefits than we would if it were targeted on KEA; and
- The existence of bonuses as well as penalties in the incentive scheme gives us greater encouragement to deliver additional fuel burn benefits for airlines rather than to simply avoid penalties in the case of the EC's KEA proposal.

Therefore, our expectation is that the UK would continue to adopt an incentive scheme based on the 3Di metric.

See Appendix O for further details on the incentive scheme.

Scope and coverage

We propose excluding the lowest levels of airspace from the 3Di score for the following reasons:

> The CAA's request in the RP3 guidance documentation that we mitigate the risk of our fuel efficiency actions having adverse impacts on community noise;

> Recent changes to government policy on noise, which are now embodied in the CAA's new airspace change guidance (CAP 1616), that noise should be prioritised over fuel burn and emissions measures in airspace below 7,000 feet;

> Airports are developing local airspace as part of their future masterplans. As a consultee we have limited control on these designs, which, in addition to prioritising noise reduction measures, may prioritise other objectives over fuel burn and emissions savings. For example, between now and the end of RP3, Edinburgh, Liverpool and Manchester airports are planning changes to the design of airspace up to 11,000 feet;

> Under future airspace strategy implementation south, airport authorities in the London region are expected to be given responsibility for designing arrival and departure routes up to 7,000 feet. We believe there may be an impact on 3Di above these levels as aircraft are initially positioned away from their most efficient routes. For departure flights we expect there will be impacts on 3Di up to 9,000 feet; and

> Airport decisions and operational factors at airfield level (runway direction) can affect airspace efficiency as described in the previous section.

We are proposing to vertically exclude low level airspace from the scope of 3Di by removing data below 7,000 feet for arrivals and 9,000 feet for departures.

This cut off has been selected to take account of current and future airport development plans, which are factors outside of our control, and the need to ensure that fuel efficiency measures do not lead to adverse noise impacts.

Exclusions and exemptions

We propose to introduce exclusions on certain flight types on the basis that they are either purposefully or inadvertently trying to achieve a different objective to efficiency. These include:

> Training and positioning flights;

> Diversions due to runway closure;

> Surveillance and calibration flights; and

> Other non-revenue flights.

Customers fed back that they supported the concept of the exclusions, although noted that some positioning flights were between existing city pairs. In those cases they still valued fuel efficiency as an objective. In response we only propose exclusions for non-standard, very short duration positioning routes, for example, less than 100 miles.

We separately propose a process of exemption of up to ten days annually where 3Di is significantly influenced by factors outside of our control, or where the resultant inefficiency of airspace has been unavoidable. Some examples include:

> Air traffic control strikes by ANSPs other than us;

> Activation of large military exercises, for example, Formidable Shield 17;

> Severe thunderstorms with substantial re-routeing; or

> System issues that are not due to us, such as baggage.

We propose that we should have the ability to highlight these days for exclusion from the metric and to agree these with the CAA retrospectively.

Triggers for adjustments

We propose that we apply adjustments to the 3Di performance scheme for changes outside of our control, which result in significant operational or performance impacts. This can be achieved by re-calculating the 3Di baseline or adjusting the target performance range. Factors include:

> The impact of implementing new, special use airspace to meet future military airspace requirements, where there are significant changes to the scope or use of danger areas, for example, the flexible use of airspace state project;

> Other changes to the designation of airspace, such as parachuting, gliding and general aviation, impacting civil air traffic routeings;

> Unmanned traffic management affecting airspace classification or leading to changes in civil air traffic routeings; and

> Where there are changes to the scope or accuracy of data capture. During RP3, we will finalise the replacement of our radar processing system, which has the potential to improve data quality. While it is not expected that there will be changes to flight profile information, there is potential for the scope of data capture to change.

Improvements in data

As a general principle, we are proposing the adoption of improvements to data that allows the 3Di metric to better reflect fuel burn outcomes for customers. For example, we are investigating the adoption of more accurate and timely information on airline flight level preferences.

Currently, the 3Di metric uses the airline's last filed flight level, from the flight plan, as the level to determine whether we have achieved the customer's requested cruise level. Subject to technical feasibility, we would suggest changing this to using the airline's last requested flight level on the day of flight. We believe that this will better reflect the airline's preferred trajectory.

Performance scheme considerations

We have identified a relationship between traffic volume and 3Di that, combined with the expected growth in traffic across RP3, predicts a deterioration in the score. This is caused by more frequent and complex interactions between flights in busier airspace.

Adopting all of the refinements to 3Di described above, the RP2 3Di target range would change the base to 16.2-17.9 3Di points. This does not reflect an improvement in efficiency but instead a change in the baseline of the score to ensure it is controllable by us.

Our core plan seeks to mitigate or, where possible, minimise the trade-off between traffic growth and flight efficiency through the capital projects in our plan and continued day-to-day operational improvements. We will maintain our 3Di target for RP3 within our projected performance band of 16.2-17.9 points p.a. at the end of RP2, or our actual performance at that date if better. Without any investment, i.e. under a do nothing scenario, we expect the score to increase by approximately one[1] 3Di point.

This expected performance outcome is based on base case traffic levels. We propose that targets are modulated where demand for air transportation significantly differs from these levels, based on the relationship we have identified between traffic growth and 3Di. Our proposal is that target modulation would be triggered when traffic varies by +/- 5% against base and is then pro rata for subsequent additional growth or contraction in traffic.

This proposal is shown in the table on the right. The table clearly shows that a +/- 10% variance on the RP3 base case forecast would result in around a +/- one point change in 3Di purely due to traffic, providing the rationale for modulation of the 3Di score due to significant traffic growth or reduction.

Scenario	3Di adjustment (points v centre of target range)
+10% variance on base case	1.16
+9% variance on base case	0.97
+8% variance on base case	0.87
+7% variance on base case	0.82
+6% variance on base case	0.66
+5% variance on base case	0.58
-5% variance on base case	-0.50
-6% variance on base case	-0.65
-7% variance on base case	-0.78
-8% variance on base case	-0.89
-9% variance on base case	-1.01
-10% variance on base case	-1.11

[1] With LAMP the 3Di score would be improved by up to two points.

Appendix H: Determined costs

In this appendix we set out the evidence for the cost efficiency of our plan. In RP2, we project that our prices will reduce by 27% in real terms from 2014 to 2019, while in RP3 average prices will be 14% lower in real terms than in RP2. During these years we will be handling increasing traffic while implementing a large modernisation programme and increasing the resilience of our operations.

Our benchmarking studies indicate that our pay levels for the majority of our operational and engineering staff, and for our corporate area staff, are broadly in line with market rates. This is important to retain and attract particular skill sets in a competitive market. Appendix I provides evidence for the efficiency of our prices, including further detail on our benchmarking studies.

Turning to headcount, we plan to increase operational resourcing levels to meet the operational requirement relating to traffic levels and airspace changes, with a margin to provide the operational resilience that is important to our customers. This is supported by analysis that shows that by following this approach we optimise both the direct and indirect costs of our service, noting that if we under-resource there would be a disproportionate indirect cost to our customers caused by delay. Further information is provided in Appendix I. Our headcount for technical services matches the requirements to deliver our airspace and technology programmes in RP3. See Appendix K for more details on headcount.

We are committed to making our costs as efficient as possible, building on the around 40% reduction in our controllable underlying operating costs since we were privatised. Our plan contains further efficiencies of £70m over RP3, the areas for which have been identified but remain to be secured and which are at our own risk.

Note that the numbers presented in this section include roundings.

Restatement of National Performance Plan for RP2 to enable comparison with projections in our business plan

This section restates the European Commission (EC) approved National Performance Plan (NPP) for RP2 to allow direct comparison to the en route projections in our business plan. Restatement is necessary for the following two reasons:

1. Determined unit costs (DUC) were calculated in the NPP based on total service units, with determined costs (DC) being grossed up for military and exempt flight service units; and
2. The financial values in the RP2 NPP were expressed in 2012 prices. The financial values in our business plan for RP3 are expressed in 2017 prices.

Key values from RP2 National Performance Plan

The tables below are extracted directly from the NPP, showing the DC and our DUC, first line only, and the UK state in total (figures in 2012 prices).

Determined costs

2012 prices £m	2014 base	2015	2016	2017	2018	2019	Compound annual growth rate (CAGR) 2014 to 2019
NERL en route	598.7	562.3	550.6	540.9	522.2	502.8	-3.4%
Met	30.6	26.4	25.7	25.0	24.4	23.7	-5.0%
NSA & DfT	51.3	55.6	56.7	57.3	57.8	57.7	2.4%
UK	680.6	644.3	633.0	623.2	604.3	584.3	-3.0%

Source: CAA calculations

Determined unit cost

2012 prices £m	2014 base	2015	2016	2017	2018	2019	CAGR 2014 to 2019
NERL en route*	59.72	54.89	52.77	51.11	48.54	45.96	-5.1%
Met	3.05	2.57	2.46	2.36	2.26	2.17	-6.6%
NSA & DfT	5.12	5.43	5.43	5.41	5.37	5.27	0.6%
UK	67.89	62.89	60.66	58.88	56.18	53.41	-4.7%

*This includes the FAS Deployment Facilitation Fund and the military service units adjustment.

The traffic forecast – expressed in total service units (TSU), which was used to generate the determined unit cost (including military service units), was based on the STATFOR[1] forecast published in February 2014. The TSUs can be seen for 2015-2019 in the table below.

Summary

NERL en route	2015	2016	2017	2018	2019
DC nominal (£m)	686.1	686.9	689.7	682.3	672.8
Inflation index (2012 = 100)	106.5	108.5	110.7	112.9	115.2
DC real (£m)	644.3	633.0	623.2	604.3	584.3
Total service units (000)	10,244	10,435	10,583	10,758	10,940
DUC real (£)	62.89	60.66	58.88	56.18	53.41

Source: CAA calculations

[1] Statistics and forecast service of the Eurocontrol Agency.

Total service units and chargeable service units - an explanation

European regulations require determined unit costs (DUCs) to be expressed using total service units (TSUs) to recover the costs of both civil and military flights. However, in the UK, military and exempt flights are funded separately and, therefore, DUCs are expressed relative to chargeable service units (CSUs) for civil flights only. This can be illustrated as follows:

$$\frac{\text{Determined costs} + \text{Exempt flights adjustment} + \text{Military adjustment}}{\text{Chargeable service units} + \text{Exempt flights service units} + \text{Military service units}} = \text{Determined unit cost (on CSU and TSU basis)}$$

The figure above shows how UK determined unit cost (civil determined unit/civil chargeable service units) is expressed in European terms by including a gross up factor (to the numerator) and adding military and exempt flight service units (SU) (to the denominator) such that DUCs calculated using TSUs produce the same result.

Determined unit cost: reconciliation using total service units and chargeable service units[2]

National Performance Plan 2015 – 2019 (based on TSUs)

Values in 2012 prices	2015	2016	2017	2018	2019
Determined cost £m	562.3	550.6	540.9	522.2	502.8
Total service units '000	10,244	10,435	10,583	10,758	10,940
Determined unit cost	54.89	52.77	51.11	48.54	45.96

Notional military adjustment/gross-up factor

Values in 2012 prices	2015	2016	2017	2018	2019
Determined cost £m	7.1	6.8	6.6	6.3	6.0
Military service units '000	130	130	130	130	130
Determined unit cost	54.89	52.77	51.11	48.54	45.96

Notional exempt flights adjustment/gross-up factor

Values in 2012 prices	2015	2016	2017	2018	2019
Determined cost £m	0.5	0.4	0.4	0.4	0.4
Exempt service units '000	8	8	8	8	8
Determined unit cost	54.89	52.77	51.11	48.54	45.96

Our plan excluding military adjustment and exempt flights (CSUs)

Values in 2012 prices	2015	2016	2017	2018	2019
Determined cost £m	554.8	543.4	533.8	515.5	496.5
Chargeable service units '000	10,106	10,297	10,445	10,619	10,801
Determined unit cost	54.89	52.77	51.11	48.54	45.96

[2] In our RP2 plan, we presented our figures in SUs and they were grossed up to a TSU basis for the NPP. Now we are presenting them on a CSU basis as this reflects our reporting requirements and our Licence, so we are using a slightly different grossing up process. As shown in the tables in this section this does not result in any difference to the DUC outcome.

Conversion to 2017 prices from 2012 prices

The following table analyses our element of the NPP, excluding the adjustment for military and exempt flight SUs, and presents this in 2012 prices. For example, the DC per SU in 2019 is £45.96.

This is then inflated to 2017 prices by applying the actual consumer price index (CPI) inflation between 2012 and 2017 (a factor of 1.0760). The resulting determined cost per CSU in 2019 (in 2017 prices) is £49.46.

Determined cost breakdown

Values in 2012 prices (£m)	NPP for RP2				
	2015	2016	2017	2018	2019
Operating costs	331.1	324.4	323.6	323.9	319.8
Pensions	74.9	74.4	74.4	68.9	65.5
Depreciation	178.9	179.0	172.5	160.2	153.5
Allowed returns	61.6	56.8	52.4	48.7	45.0
Non-regulated revenues	(91.8)	(91.2)	(89.2)	(86.2)	(87.3)
Total determined costs	**554.8**	**543.4**	**533.8**	**515.5**	**496.5**
Chargeable service unit forecast	10,106	10,297	10,445	10,619	10,801
Determined cost per CSU	54.89	52.77	51.11	48.54	45.96
2012 to 2017 inflation (CPI)	1.0760	1.0760	1.0760	1.0760	1.0760
Values in 2017 prices (£m)	NPP for RP2				
	2015	2016	2017	2018	2019
Operating costs	356.3	349.0	348.2	348.5	344.1
Pensions	80.6	80.0	80.0	74.2	70.5
Depreciation	192.5	192.6	185.7	172.3	165.2
Allowed returns	66.3	61.2	56.4	52.4	48.5
Non-regulated revenues	(98.8)	(98.1)	(95.9)	(92.7)	(94.0)
Total determined costs	**596.9**	**584.7**	**574.4**	**554.7**	**534.2**
Chargeable service unit forecast	10,106	10,297	10,445	10,619	10,801
Determined cost per CSU	59.07	56.79	54.99	52.24	49.46

Determined cost projections

Our regulatory model (described in Appendix O) expresses the determined costs (after deducting non-regulatory income) to be recovered from customers using a building block approach.

These regulatory building blocks, which make up our plan's determined costs for RP3, are shown in the tables on the next page. These are also analysed between en route and oceanic, with all values expressed in constant 2017 prices, deflated by CPI.

In total, our determined costs for RP3 are £3,298m in 2017 prices (deflated by CPI). £3,155m relates to the en route service and £143m relates to the oceanic service.

Total NERL determined cost

2017 CPI prices (calendar year) £m	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	RP2	RP3
	Actuals	Actuals	Actuals	Forecast	Forecast	Plan	Plan	Plan	Plan	Plan	Total	Total
Efficient operating costs:												
– Staff & direct underlying costs	363	375	363	395	427	434	433	450	447	436	1,923	2,201
– Exceptional costs	1	1	1	8	13	2	2	2	2	2	23	8
– Opex flexibility fund	0	0	0	0	0	7	7	7	7	7	0	35
Cash pension contributions - defined benefit	79	78	78	71	66	65	64	63	60	40	372	292
Cash pension contributions - defined contributions	5	5	6	7	8	11	13	14	15	16	31	68
Cash pension contributions - pension cash alternative	0	0	0	0	0	17	16	15	14	13	0	74
Regulatory depreciation	198	198	190	177	170	194	160	142	147	158	933	801
Regulatory return (inc. tax charges)	71	66	61	59	59	52	57	60	60	59	316	287
Non-regulatory income	(106)	(115)	(115)	(98)	(95)	(97)	(94)	(92)	(92)	(92)	(530)	(467)
Total	611	608	584	618	647	684	656	660	659	638	3,069	3,298

En route determined cost

2017 CPI prices (calendar year) £m	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	RP2	RP3
	Actuals	Actuals	Actuals	Forecast	Forecast	Plan	Plan	Plan	Plan	Plan	Total	Total
Efficient operating costs:												
– Staff & direct underlying costs	347	359	349	379	410	417	415	432	430	419	1,845	2,113
– Exceptional costs	1	1	1	7	12	2	2	2	2	2	23	8
– Opex flexibility fund	0	0	0	0	0	7	7	7	7	7	0	35
Cash pension contributions - defined benefit	76	75	74	68	63	62	61	60	58	39	356	281
Cash pension contributions - defined contributions	5	5	6	7	7	11	12	13	14	15	30	65
Cash pension contributions - pension cash alternative	0	0	0	0	0	16	15	14	13	12	0	71
Regulatory depreciation	193	193	186	172	165	187	154	137	141	152	909	771
Regulatory return (inc. tax charges)	69	64	59	56	57	49	55	58	58	57	305	277
Non-regulatory income	(106)	(115)	(115)	(97)	(94)	(97)	(93)	(92)	(91)	(91)	(527)	(464)
Total	585	583	560	592	620	655	628	631	631	611	2,940	3,155

Oceanic determined cost

2017 CPI prices (calendar year) £m	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	RP2	RP3
	Actuals	Actuals	Actuals	Forecast	Forecast	Plan	Plan	Plan	Plan	Plan	Total	Total
Efficient operating costs:												
– Staff & direct underlying costs	16	15	14	16	17	17	18	18	18	17	78	88
– Exceptional costs	0	0	0	0	1	0	0	0	0	0	1	0
– Opex flexibility fund	0	0	0	0	0	0	0	0	0	0	0	0
Cash pension contributions - defined benefit	3	3	3	3	3	2	2	3	2	1	16	11
Cash pension contributions - defined contributions	0	0	0	0	0	1	1	1	1	1	1	3
Cash pension contributions - pension cash alternative	0	0	0	0	0	1	1	1	1	1	0	3
Regulatory depreciation	6	5	5	4	4	7	6	5	6	6	24	30
Regulatory return (inc. tax charges)	2	2	2	2	3	2	2	2	2	2	11	10
Non-regulatory income	(1)	(0)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(3)	(3)
Total	26	26	24	26	27	29	29	29	28	27	129	143

Explanatory notes and key assumptions see page 50.

Explanatory notes and key assumptions:

1. Values for the depreciation of the regulatory asset base (RAB) and cash pension contributions for the RP2 period reflect the allowances/assumptions made by the CAA. The values for oceanic determined costs above, exclude satellite data charges, which are described in Appendix M.
2. Determined cost projections for RP3 exclude true-ups relating to under or over recovery of traffic volume variances, inflation variances and incentives. They exclude our best estimate of cost exempt true-ups in relation to cost variances such as pension and spectrum cost, which will be reviewed and approved after the end of RP2 . These true-ups affect prices only (they do not affect determined cost, or determined unit costs). This is described further in Appendix O.
3. Determined cost projections for RP3 do include true-ups relating to capital expenditure variances between our latest forecast for RP2, and the value originally assumed by the CAA, recovered within regulatory depreciation, consistent with RAB rules.
4. The value of the RAB at 1 January 2020 will need to be adjusted retrospectively to reflect actual experience during RP2, rather than any best estimates which may be necessary for practical reasons to enable the completion of our business plan for RP3 and CAA's National Performance Plan in accordance with the regulators' timetables. This will include differences between the actual capex (when known at the end of RP2) and our latest forecast for RP2, which will be recovered through prices in future reference periods (post RP3), consistent with RAB rules.
5. Our determined cost projections shown above assume that the CAA will make full allowance for our projected defined benefit and defined contribution costs. It is also assumed that the CAA will make full allowance for NERL's RP3 projected pension cash alternative allowance (paid in lieu of employer DB pension contributions for members opting out of the DB scheme), recorded in the pension component of determined costs, which is consistent with the approach taken in our cost exempt submission for 2016. These costs are also shown in the tables above.

Each building block at NERL level is described in the sections that follow:

> Efficient operating costs;

> Cash pension contributions;

> Regulatory depreciation;

> Regulatory return (including tax charges); and

> Non-regulatory income.

Efficient operating costs

The tables and commentary below show the component parts of the efficient operating cost building block:

> Staff and direct underlying costs – these are the direct costs of running the business, excluding pension and restructuring costs;

> Exceptional costs – one-off costs such as restructuring costs; and

> Opex Flexibility Fund – funds to provide flexibility so we can deliver the most cost efficient outcome for customers, representing around 1% of total income.

Staff and direct underlying costs

These costs comprise staff costs (less any internal labour costs that are capitalised), non-staff costs, and intercompany costs (for which income and margin is received). These are summarised as follows:

Total NERL staff & direct underlying costs

2017 CPI prices (calendar year) £m	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	RP2	RP3
	Actuals	Actuals	Actuals	Forecast	Forecast	Plan	Plan	Plan	Plan	Plan	Total	Total
Staff costs	273	275	282	304	304	315	319	320	314	313	1,439	1,580
Capitalised internal labour	(53)	(47)	(57)	(54)	(46)	(52)	(60)	(44)	(40)	(46)	(256)	(242)
Non-staff costs	115	121	112	121	143	146	147	149	147	143	613	732
Intercompany costs	27	26	26	24	25	26	26	26	26	26	127	131
Total	363	375	363	395	427	434	433	450	447	436	1,923	2,201

Staff costs and capitalised labour

Staff costs are driven mainly by projections on headcount and pay. See Appendix K for more details on each headcount category.

Total NERL headcount

Total NERL headcount FTEs	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	Actuals	Actuals	Actuals	Forecast	Forecast	Plan	Plan	Plan	Plan	Plan
Operations - Operational Air Traffic Controllers	950	938	915	889	868	906	953	999	1,017	1,018
Operations - Trainee Air Traffic Controllers	31	62	116	201	305	323	266	221	203	195
Operations - Support	822	821	845	935	970	965	963	958	938	928
Technical Services	979	985	1,028	1,076	1,033	1,017	997	946	872	839
Other Support Staff	373	389	396	401	402	438	451	456	456	456
Total	3,155	3,196	3,300	3,503	3,578	3,649	3,630	3,581	3,486	3,435

Operations – operational air traffic control officers (ATCO): Mainly provide air navigation services and network management roles. The profile shows a reduction towards the end of RP2 due to higher retirements and leavers than our training lead time can replace. For a time, this means that our headcount is below operational requirement and we are managing this through increased productivity i.e. being able to control more aircraft with the same number or fewer controllers, and overtime. From 2019, the profile increases to meet the operational requirement to support increasing traffic, provide operational resilience and ramps up to meet the demand for a third runway at Heathrow.

Operations – trainee air traffic controllers (TATC): Our air traffic controllers of the future. These increase significantly from the middle of RP2 reflecting the increased demand for ATCOs as noted above. After peaking in 2020, they then reduce to a level required to maintain the operational requirement.

Operations – support: Provide support to the operation or to the operational development programme through management of the operation, ATCO training, safety management and improvement, and airspace design. Some of the people working in operations support retain a valid ATCO licence enabling them to supplement the operations teams on a part-time basis reflecting the needs of the operation. The profile reflects the operational requirement to support the day-to-day operation and the delivery of our airspace and technology programme.

Technical services: Largely engineers and project management professionals either supporting our current operational systems or delivering our future systems into operation. The increased profile towards the end of RP2 is driven by the size of our airspace and technology programme and support for our training programme. It also includes the resources required to run our future systems alongside our current systems through the dual running phase, and the development of our Portfolio, Programmes and Projects Office (P3O) function with increased governance around our change portfolio. In RP3, the profile reduces as we switch our current systems off and the engineering requirement in our airspace and technology programme reduces in size.

Other support staff: Working on activities including safety, human resources, finance, legal and communications. These are projected to increase in RP3, reflecting additional requirements including work on safety, airspace change and improving resilience. These projections also include the resources required to support unmanned aircraft system traffic management (UTM) activities to maintain safety levels within controlled airspace, and investment in our future ATM capability. See below for more information.

The capitalised internal labour profile reflects the deployment schedule of the capital investment plan described elsewhere in this plan.

Non-staff costs and intercompany costs

Non-staff costs are projected to increase to reflect the following:

1. Moving from our current legacy asset based systems to a managed service on our new infrastructure. See Appendix K for more details on these costs.

2. Outsourcing the training of some controllers in order to provide the numbers required to support increasing traffic and provide operational resilience. See Appendix K for more details on training in general.

3. Costs of research and development for developing our ATM capability as the UK exits the EU and we are unlikely to have access to EU funding in future. These are necessary to harness future developments in technology to deliver improvements in future performance and efficiency and to de-risk our investment programme in the long term.

During RP1 and RP2 we have focused on our strategy for supporting the EU-wide ATM master plan which is designed to introduce consistency in technology across Europe. Part of this implementation has involved us supporting the European SESAR joint undertaking, for which we are leading a number of work packages. In RP3, the pace of change is increasing and there are questions over what funding we might be eligible for post-Brexit.

ATM is becoming increasingly technology-intensive as traffic demand increases in a finite volume of airspace, particularly over London. Advances in automation are beginning to surpass human capability, with technology support becoming common place in every aspect of our lives. Automation, artificial intelligence and machine learning can offer improvements for our operation moving away from a people-centric operation (reducing operating and pension costs) and harnessing the advances in aviation (aircraft equipage and capability) to improve performance.

Furthermore, we must ensure ATM is connected to the wider transport network as interconnected transport concepts come into service, allowing us to maximise predictability, punctuality and overall passenger experience. The content of this programme will evolve as new technologies and capabilities emerge. The key areas of focus in RP3 are:

> Safe integration of all airspace users, particularly as UTM activity increases;

> Validation of our near future concepts, individually and in combination;

> Use of data to better predict and respond to demand patterns and improve customer service;

> Development of automated and optimised ATM decision-making capability in highly systemised airspace; and

> Identification and response to new and emerging trends and concepts.

Benefits are captured in our investment plan under safety, service (increased capacity, reduced delay, improved resilience), value (cost efficiency through cost avoidance and reduced opex) and environment (reduced fuel burn and CO_2 emissions). We undertake work on feasibility and options before the projects proposals reach sufficient maturity to become an investment project, and to support projects as they are developed and integrated into service. This understanding of a project proposal in advance of it reaching maturity helps to:

> De-risk delivery into the operation;

> Maximise the operational optimisation of the benefits;

> Support achieving best value from suppliers;

> Drive operational and technological strategies, and future roadmaps; and

> Provide expertise to assist in system recovery and failure mitigation.

Benchmarking on this sort of activity differs between industries, individual companies and what is defined as research and development (R&D) activity. We operate in a technology-intensive industry, relying on tools and systems to support safety critical, 24x7x365 operations in some of the world's most complex and constrained airspace. Numerous reports cite R&D expenditure in the region of 2%-4% of turnover, increasing for technology-intensive industries and companies. DFS (an aviation-specific comparator), reported >€40m p.a. R&D expenditure over recent years (6% of turnover in 2017). By contrast, we have reported around £8.5m p.a. over the last 4 years (<2% of turnover). The government has targeted 2.7% of GDP on R&D expenditure by 2027.

Core non-staff costs such as facilities management compare favourably with comparable industry benchmarks[3] and reflect the benefits of site sharing.

Our procurement processes are regularly reviewed against industry best practice. They have been assessed as being at the highest level - platinum - by the Chartered Institute of Procurement and Supply. This is evidenced by a number of processes which ensure that our third party spend achieves value for money, taking into account market and vendor analysis, technology trends, future business requirements and the various sourcing options available. We also undertake in-depth supplier performance monitoring, regular supplier and contract reviews, and supplier improvement plans.

Intercompany costs (charges to NERL from NSL or the NATS group) are projected to rise very slightly in RP3 primarily due to increased requirements to ensure the safety of all airspace users due to increasing drone activity.

[3] As assessed across main occupational, operational and efficiency per person costs by JLL Global Benchmarking Service in a study in November 2017.

Exceptional costs

Exceptional costs are mainly redundancy costs. These increase towards the end of RP2 in order to re-balance our non-ATCO workforce to ensure that we have appropriately skilled people in RP3 to support our future systems. These costs, which will exceed the allowance made in RP2 and which we will bear, will deliver benefits in RP3 and beyond.

Natural levels of attrition assumed in our plan are relatively low, as many of our employees join the company for a long term career and there is no mandatory retirement date. For this reason, it is not possible to achieve the level of re-balancing required in our non-ATCO workforce during RP2 without a redundancy programme. Looking into RP3 our current assessment of the resourcing requirement suggests that we can manage this without formal restructuring.

Opex Flexibility Fund

The Future Airspace Strategy (FAS) Facilitation Fund was introduced in RP2 to allow us to fund unforeseen activities required to deploy FAS. The fund replaced an opex contingency allowance. However, the processes governing the FAS Facilitation Fund (FFF) restrict our ability to secure funds quickly to respond to changing conditions and requirements. The scope of the fund is also limited.

To mitigate these shortcomings, our core plan contains an additional Opex Flexibility Fund averaging £7m p.a. in real prices. This fund replaces the current FFF. We support the continuation of the Small Gaps Fund and propose that it is funded through the CAA/DfT component of the unit rate.

The size of the fund is similar to the contingency allowance in CP3 (2011-2014). We believe that this strikes an appropriate balance between being efficient (£7m is approximately equivalent to 1% of revenue) while providing sufficient funds to address requirements. Any unused funds would be returned to customers at the start of RP4.

The fund gives us the flexibility to deliver the most cost efficient outcome for customers. It allows us to make decisions to respond to changes in the external operating environment more quickly than the current FFF process. This will provide better outcomes for customers.

We envisage that the fund could be used in two ways:

> Opex/capex switch: To give us the flexibility to deliver a project using a different mix of operating and capital expenditure from that currently planned; and

> Delivery of core plan programmes: To allow us to address specific key risks or unforeseen circumstances to ensure that core plan projects that are important to customers can be delivered on time.

Without the Opex Flexibility Fund, our ability to respond to external changes in conditions would be constrained, meaning that we would need to price risk into our plan. We believe this would lead to a worse outcome overall for customers.

See Appendix O for further detail on the Opex Flexibility Fund, including the regulatory mechanisms.

Pension costs

We provide our staff with pension benefits through either a defined benefit pension scheme, which closed to new members on 1 April 2009, or a defined contribution scheme. We have also provided defined benefit pension members with the option of a pension cash alternative in the event that they choose to defer membership or opt completely out of the scheme for tax or other reasons following independent financial advice. The table on the following page sets out these costs.

Total NERL pension costs

2017 CPI prices (calendar year) £m	2015 Actuals	2016 Actuals	2017 Actuals	2018 Forecast	2019 Forecast	2020 Plan	2021 Plan	2022 Plan	2023 Plan	2024 Plan	RP2 Total	RP3 Total
Cash contributions												
– Future service	60	57	44	37	36	46	45	44	42	40	235	218
– Deficit repair	22	23	30	30	31	18	18	19	19	–	137	74
Defined benefit	**83**	**80**	**75**	**68**	**67**	**65**	**64**	**63**	**60**	**40**	**372**	**292**
Defined contribution	4	5	6	8	10	11	13	14	15	16	32	68
Pension cash alternative	–	1	11	18	17	17	16	15	14	13	48	74
Total pension costs	**87**	**86**	**91**	**93**	**94**	**93**	**92**	**91**	**89**	**68**	**452**	**433**
As a % of pensionable pay												
– Future service	29%	29%	32%	32%	32%	42%	42%	42%	42%	43%		
– Deficit repair	11%	12%	22%	26%	27%	17%	17%	18%	19%	–		
Defined benefit	**40%**	**41%**	**53%**	**58%**	**59%**	**58%**	**59%**	**60%**	**61%**	**43%**		
Defined contribution	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%		
Pension cash alternative	–	28%	28%	26%	26%	27%	27%	27%	27%	26%		
Total pension costs	**37%**	**37%**	**42%**	**39%**	**39%**	**37%**	**36%**	**36%**	**36%**	**28%**		

The values in the table above reflect our latest actuals/estimates for all years of RP2, rather than the allowance/assumptions made by the CAA.

Defined benefit scheme

Background

We operate a final salary pension scheme which was closed to new members on 1 April 2009. Members of this scheme benefit from significant protections provided by the trust deed and rules (trust rules), which includes a no decrement clause. We have taken counsel's advice on the lawfulness of changes to our scheme, which other employers have adopted, to mitigate increasing cost and risk of their schemes. The advice concluded that the no decrement clause prevents any amendment that reduces previously accrued or prospective benefits of existing members, and prevents any increase in member contribution rates. These protections were further reinforced at Public Private Partnership (PPP) through the trust of a promise (TOAP). Scheme changes that have been made are summarised later.

During 2016 and 2017, 922 active members deferred their membership or transferred out to take advantage of the pension cash alternative offered in lieu of employer defined benefit pension contributions. The pension cash alternative is less costly and lower risk than the costs for ongoing future service accrual and customers will benefit from these reductions through lower prices. The number of active members fell from 3,264 at 1 January 2016 to 2,038 at 31 December 2017, with transfers out reducing scheme assets and liabilities by around £1.7bn. This represents a significant de-risking of our exposure to the scheme.

Current position

Our projected contributions for RP3 represent NERL's share of the NATS group scheme, using our cost allocation model which is reviewed by CAA-appointed consultants at each regulatory review. These projections reflect the outcome of the trustees' most recent valuation as at 31 December 2017 (the 2017 valuation), and advice from Mercer, our actuarial advisor. The 2017 valuation was brought forward by one year (from 31 December 2018) to inform this business plan.

The 2017 valuation reported a deficit of £270m (a funding ratio of 94%) with the scheme's liabilities at £4.8bn. This is a reduction in the deficit from £459m (a funding ratio of 91%) reported following the 2015 valuation. This is also less than the 2012 valuation deficit of £383m (a funding ratio of 90%), which informed the RP2 projections. Our economic share of the scheme is 76% with other group companies accounting for the remaining 24%. Although the 2017 deficit has reduced (driven by strong investment returns and demographic factors), the reduction in real interest rates since the last valuation has increased the cost of future benefit accrual to 41.8% of pensionable pay from 31.8% at the 2015 valuation and 29.4% at the 2012 valuation (all in respect of CPI-linked accrual).

Extensive consultation took place between the scheme, the scheme actuary and NATS during the 2017 valuation process. During the consultation, all valuation assumptions, which are set by trustees, were reviewed. We consider that the assumptions are in line with relevant benchmarks and are reasonable.

Actions we have taken to mitigate the cost and risk of the defined benefit scheme

As we expected when we created our business plan for RP2, our pension contributions have been higher than the revenue allowances assumed in RP2 prices. This is mainly because of the continuing low (negative) real interest rate environment, which has not yet reverted to more normal long term historical levels.

As noted above, the legal protections, afforded by the trust rules and TOAP, rule out actions that are available to many other companies with defined benefit schemes, for example, increasing employee contributions or closing the scheme to existing members. We are acutely aware that, ultimately, it is our customers who bear the costs of pension benefits and we seek to take actions to mitigate the cost and risk of the defined benefit scheme accordingly. Within our legal constraints we have taken all reasonable actions that are meaningfully available. These include:

> Scheme closure: Closing the scheme to new entrants, with effect from 1 April 2009, following constructive and challenging discussions with trades unions, and achieved with no adverse impact on service delivery;

> Pensionable pay: Capping increases in general pensionable pay for existing members with agreement and support from our trades unions (retail price index (RPI) + 0.5% until 2013 and then CPI + 0.25%, each year until January 2024);

> Indexation of liabilities: With support from our trades unions, requesting trustees to index annual pension increases in respect of service earned after 1 November 2013 by CPI rather than by RPI. Trustees agreed to this request; and

> Pensionable pay rise assumptions: Requesting trustees to adopt annual pay increase assumptions for the calculation of future liabilities, based on CPI rather than CPI + 0.25% due to the trend in actual pay awards. Trustees agreed to retain CPI in the 31 December 2017 valuation. When adopted for the 31 December 2015 valuation, alongside a reduction in the assumed rate of promotional increases, this resulted in around a £65m reduction in liabilities.

As a result of the 2013 changes to indexation and the pensionable pay cap, we avoided cost increases in RP2 of around £200m. Further, we previously estimated that the changes made to the scheme in 2009 would result in avoided cost increases of around £600m over the ten-year period from 2016. Further mitigations included the following:

> Pension cash alternative: Introducing a pension cash alternative in lieu of employer pension contributions for staff opting out of the defined benefit scheme for tax and other reasons based on independent financial advice. Including national insurance, this alternative pension allowance costs 28.5% of pensionable payroll, which is a fixed cost and less costly than the cost of future benefit accrual of 41.8%. Based on staff opt outs at 31 December 2017, this represents a saving of around £10m p.a. from 2020. The existence of the pension cash alternative is likely to remain an effective cost mitigation in the future. The rate of this allowance is reviewable and will take into account the costs of future service following every triennial valuation.

In addition, as explained above, to the extent that members opt out and then take a cash equivalent transfer value, this significantly de-risks our exposure to pension liabilities. Scheme assets and liabilities have been reduced by around £1.7bn since 1 January 2016 by removing the risk of a future deficit arising with respect to those liabilities. Customers will benefit from the substitution of the lower pension cost allowance for the higher future service cost as this is passed on through lower prices.

> Transfer values: Ensuring that calculation of cash equivalent transfer values by the trustee is based on best estimate assumptions.

> Scheme governance: Continuing to ensure good governance of the scheme through the efforts of our nominated trustees, including input to the scheme's investment strategy. As funding levels have improved, changes to the investment strategy have reduced the exposure of the scheme to return seeking assets, along with increased hedging of the real interest rate exposure of the scheme's liabilities. As an example, it has been estimated that by significantly increasing real interest rate hedge ratios over the last few years (from around 25% to over 50%), the scheme's deficit is around £375m lower than would have otherwise been the case, given changes in real interest rate levels since the previous valuation (31 December 2015).

> Deficit repair plan: Maintaining the end date of the recovery plan (and the associated expected investment outperformance period) as at 31 December 2026, rather than bringing it forward by three years to reflect the improved funding position. As a result, deficit repair contributions over RP3 will be around £40m lower. This proposal, which is more affordable, also reduces the risk of a trapped surplus. Further, due to the additional benefit of the improved funding position of the scheme, the deficit repair contributions over RP3 will be around £70m lower than those previously agreed at the 2015 valuation.

> Statutory override: Consulting the Secretary of State for Transport (in his capacity as a shareholder of NATS) on implementing the statutory override provisions. These were intended to enable benefit or contribution changes to UK defined benefit (DB) schemes to offset cost increases following the cessation of the contracted-out national insurance status of all DB schemes. The circumstances under which a fair balance of cost and benefit between employer and employee was intended to be restored by the override applied fully to our scheme. However, protections introduced at PPP meant that the override could not be applied without shareholder consent. We were disappointed to be advised that consent was not granted, barring us from passing some of the employer national insurance costs to scheme members who stand to benefit from the introduction of the higher flat rate state pension. The company decided not to apply the override to the minority of active members who were not subject to that protection due to the payroll complexity and employee relations challenges that would have arisen for a relatively small benefit. The benefit

that either of these changes would have obtained had we been permitted to apply the override has been reduced by the large number of active members who transferred out of the scheme, as explained above.

> Indexation of past service liabilities by CPI: During 2017, amid volatile market conditions and a consequential risk of a significantly higher scheme deficit we held initial discussions with trades unions, and subsequently with trustees, about the potential for aligning the inflation index for all scheme liabilities by adopting CPI for past service (i.e. service accrued before 1 November 2013, not just for future service liabilities, which are already indexed by CPI). Given the extensive mitigations of scheme costs described earlier, we see this change as the last realistic option for mitigating the long term costs given the protections from PPP by which we are constrained. The lawfulness of such a change, despite having been applied by other schemes to date, was tested for another scheme at the Supreme Court in summer 2018 but the judgement is still pending.

The valuation at 31 December 2017 revealed an improved funding position compared to previous indications. In light of this, the agreements negotiated in 2013 with staff that mitigated the cost and risk of the scheme preclude a formal request to the trustees. Assuming no further material deterioration in market conditions it is very unlikely that there would be any formal request of the trustees to further change indexation before 2024.

The trustees have a policy of reviewing indexation for the scheme on a regular basis, normally linked with valuations. This is a matter entirely for the trustees and at their meeting on 5 October 2018 they considered the issue with input from their legal, actuarial and covenant advisers, as well as advice from Pensions Counsel. This followed a detailed review of indexation within the scheme, considering a wide range of factors the trustees considered to be relevant, that had taken a number of months to carry out. We are aware that this included considering in detail the CAA's position on setting the RP3 price control and of the obligations on us to properly manage our pension costs. Although the trustees only felt able to reach an "in principle" decision (based on advice from Counsel) due to the judgement in the Supreme Court case mentioned earlier still being pending, the trustees have informed us that at this time they do not believe it is appropriate for the scheme to move away from RPI for past service indexation. The trustees will confirm this decision (or otherwise) following the Supreme Court's judgement.

Turning to long term funding, and in response to the CAA's CAP 1625 requirements document, we continue to have discussions with the trustees around an appropriate long term funding target and associated long term investment strategy. While the ultimate decision around the long term investment strategy rests with the Trustees, we favour adopting an approach which ultimately targets funding the scheme on a long term low risk basis as opposed to funding the scheme towards a buy-out. This would reduce the chance of deficits emerging in the future but be more cost effective than targeting a buy-out, which would be the Trustee's preference in the absence of long term covenant support. A policy statement from the CAA providing assurance on the long term funding commitment for the scheme through future regulatory settlements would provide further support for our favoured approach.

If a surplus on the scheme arises in future, we will work closely with trustees to ensure that an appropriate balance is struck between using this opportunity to de-risk the scheme towards an appropriate long term investment strategy and reducing the projected level of future pension contributions, which in turn would reduce prices. Having a measured and balanced approach to de-risking and contribution reduction will minimise the likelihood of a trapped surplus and better reflect the interests of customers.

In combination, the actions above have significantly reduced the adverse impact of current financial market conditions, thereby avoiding materially higher pension costs in RP3 and beyond.

Regulatory considerations

When assessing the funding position of the scheme, trustees are required by law to adopt assumptions that include a margin for prudence. The financial strength of the employer determines the degree of prudence trustees adopt in the valuation of the scheme's liabilities and the level of risk that can be supported in the scheme's investment strategy.

In assessing our financial strength, trustee perception of risk is determined by confidence in the regulatory framework for the funding of pensions costs including, importantly, the pass-through provisions of the current Single European Sky framework. Were trustees to lose confidence in the regulatory framework for the funding of pensions costs, their perception of risk could rise and they might adopt a more cautious approach to pension deficit recovery and the scheme's investment strategy, leading to higher costs in RP3 and beyond.

The CAA noted in CAP 1511 and CAP 1625 the link between trustees' confidence in the regulatory framework and the level of pension costs and invited us to set out in our business plan constructive suggestions for the regulatory regime that might help improve the strength of the covenant and thereby facilitate a lower pension cost burden for our customers. We consider that there is a strong case for having a regulatory policy statement on pension costs, including the associated pass-through provisions. Such a statement could enable trustees to adopt a long term funding and investment target that strikes the right balance between the interests of our customers and the long term strategy of the scheme. All other things being equal, if trustees can place greater reliance on the employer's covenant, then higher investment returns (and associated risk) can be targeted which could lower the expected long term pension contributions and hence prices. For a fund of this size, and based on the characteristics of the scheme, our advisers have estimated that targeting additional returns of 25bps in the long term funding target and investment strategy would reduce the assets expected to be needed today by around £400m, to pay the benefits of the scheme.

The benefits to trustees and also to customers of such a statement apply both to circumstances where Single European Sky regulations do and don't continue to apply to CAA and us. Were these regulations no longer to apply, then trustees would benefit from formalisation of the regulatory framework for pension costs including pass-through provisions. If the regulations were to continue to apply, there is a risk of change to the nature of the regulatory framework for pension costs, including pass-through provisions. The limited influence the UK will have on such changes will rely on CAA support which will be enhanced by the existence of a regulatory policy statement.

We include in Appendix O, the principles that we consider should be included in a regulatory policy statement on pension costs. These principles set out what we envisage the CAA should reasonably expect from us and from the trustees, along with the assurance that we and trustees would expect from the CAA.

Our prices for RP3 will include true-ups for pension pass-through adjustments relating to RP1, which have already been approved by the CAA and the EC. Both regulators will assess our pension costs for RP2 after the end of the reference period. True-ups relating to RP2 will be reflected in prices for RP3 and future reference periods, with recovery expected over the same period as regulatory depreciation, i.e. 15 years (assuming no change is made by the EC to charging regulations for RP3).

Defined contribution scheme

Since the closure of the defined benefit scheme to new entrants in April 2009, we have offered new employees membership of a defined contribution scheme. We pay employer contributions that match employee contributions on a 2:1 basis up to a maximum employer cost of 18% of pensionable salary. We are not exposed to costs beyond this level. In practice, the average cost is 15% of pensionable salary, and this is the basis for our projections.

The scheme's membership has increased from 472 at January 2015 to 893 at December 2017. The size of the scheme and its membership will continue to increase during RP3, as new joiners replace leavers and retirees who were members of the defined benefit scheme.

Regulatory depreciation

A breakdown of regulatory depreciation is shown in the table below.

Total NERL regulatory depreciation

2017 CPI prices (calendar year) £m	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	RP2	RP3
	RP2 Settlement	RP2 Settlement	RP2 Settlement	RP2 Settlement	RP2 Settlement	Plan	Plan	Plan	Plan	Plan	Total	Total
Depreciation of opening RAB	40	40	41	42	42	42	11	0	0	0	205	52
Other regulatory depreciation	155	151	143	136	131	141	138	131	135	146	716	691
Backlog adjustments	(4)	(4)	(4)	(4)	(4)	11	11	11	12	12	(19)	57
CP3 RIM	7	10	10	3	0	0	0	0	0	0	30	0
Total	198	198	190	177	170	194	160	142	147	158	933	801

Depreciation of the RAB is driven mainly by depreciation charges relating to capital expenditure made in previous reference periods and, to a much lesser extent, RP3.

The opening value of the RAB at PPP is being depreciated over 20 years and will be fully depreciated by 2022. Capex additions to the RAB since 2011 are currently depreciated over 15 years to reflect the average expected useful life of our asset base. As a result, recovery of investments made in RP3 will continue beyond the end of this period.

Backlog adjustments are true-ups for differences in depreciation allowances between the level of actual capex and the level assumed in previous regulatory price controls. True-ups could arise from differences in timing or amount. These are higher in RP3 as we have accelerated DSESAR.

RP2 included revenues that were earned by us under the terms of the CP3/RP1 rolling incentive mechanism (RIM). The RP2 settlement did not include a RIM.

In CAP 1625, the CAA asked us to consider whether our financial robustness would be enhanced if regulatory depreciation was re-profiled. Our assessment indicates that no re-profiling is required.

Non-regulatory income

Other non-regulatory income reduces determined costs and, therefore, our prices through a single till mechanism.

Total NERL non-regulatory income

2017 CPI prices (calendar year) £m	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	RP2	RP3
	Actuals	Actuals	Actuals	Forecast	Forecast	Plan	Plan	Plan	Plan	Plan	Total	Total
MOD revenue	48	49	46	44	43	45	43	42	42	42	229	215
London Approach	12	13	13	13	13	13	13	13	13	14	64	66
North Sea helicopters	9	9	9	8	9	9	9	9	9	9	44	43
Income from NSL	25	27	27	26	23	23	22	21	21	21	127	108
Other revenue	12	18	21	7	7	8	7	7	7	6	66	35
Total	106	115	115	98	95	97	94	92	92	92	530	467

Ministry of Defence (MOD) income reflects our best estimate of the likely value of the extension to the future military area radar service (FMARS) contract, which is currently being negotiated with the MOD. Under this contract, which was agreed in 2006 and expires in 2021, the MOD pays for the shared use of our infrastructure. Since 2006, our cost base has reduced significantly. As a result, the value of the contract, which will be extended after March 2021, is expected to reduce by up to 10% in real terms (average RP3 v average RP2). Without the income from FMARS, our prices would rise by around 7%.

The value of FMARS income in our business plan has been updated to reflect discussions with the MOD during summer 2018. It is possible that the MOD may not be in a position to approve the duration or pricing of a contract extension until after the National Performance Plan for RP3 has been published. Due to the material value of the FMARS contract, we would like the opportunity to discuss ways to address this potential uncertainty with the CAA, if necessary. We are also assuming, as discussed with the CAA, that there will be an opportunity to adjust the value of MOD revenues if the level of FMARS income is affected by changes made by the CAA to the UK Performance Plan, e.g. changes to operating cost, finalisation of the cost of capital.

London Approach income reflects the charges that are no less cost reflective than the level assumed by the CAA in the RP2 determination.

Income from North Sea helicopters reflects charges anticipated from the offshore en route ATS provision, in support of the oil and gas industry and the offshore renewables industry, and is projected to remain relatively flat over the period.

Income from NSL represents revenue earned by NERL from intercompany transactions with NSL, including a contract to modernise air traffic management assets and services over 100 MOD locations (Project Marshall). Total income is projected to decline in RP3 due to a reduced pipeline of expected work from NSL. This follows the completion of the asset provision programme on Project Marshall and our reduced capacity to provide training services to NSL as we train more of our controllers.

Other revenue includes SESAR funding up to the point at which this is likely to end following Brexit, and external business revenue. This is also projected to reduce in RP3, largely due to the SESAR deployment manager becoming a separate legal entity so we will no longer receive the revenue and we will not have the corresponding costs.

Appendix I: Evidence for our efficient costs

Staff cost benchmarking

We have a negotiated grading structure covering the majority (around 3,000) of our 3,300 workforce. The grading structures are:

> Incremental spine point structures for operational roles – air traffic control officers (ATCO) and air traffic assistant (ATSA); and

> Performance related scale for all others – managerial support grades (MSG), engineers (ATCE) and scientific (STAR).

Operational and engineering roles are unique and complex in nature, and therefore a simple comparison to UK benchmarking sources using Hay Group methodology is not credible. Therefore, we engaged economic consultants NERA to benchmark costs for our operational and engineering personnel (ATCO, ATSA and ATCE) using a more sophisticated wage equation technique. This takes account of several factors that drive pay for operational roles.

We have also developed comparisons of pay for non-operational staff, for the business as a whole and for corporate functions. We have collective job evaluation arrangements for MSG grades using the Hay Group methodology, enabling the use of formal evaluation methods and access to a large sample of comparative benchmark information. This can also be applied to personal contract group (PCG) employees, although it should be noted that PCG salaries are negotiated directly and are not subject to collective bargaining pay deals.

In the sections below we set out our findings from both benchmarking studies.

Staff cost benchmarking for operational, engineering and support staff subject to collective bargaining

We engaged NERA to benchmark our staff costs using a wage equation approach. This uses publicly available data (from the Labour Force Survey, published by the Office for National Statistics) to estimate the market compensation level for staff grades which are subject to collective bargaining (ATCO, ATSA, ATCE, STAR and MSG). The approach enabled NERA to account for variables in calculating these estimates, such as location, age, experience and education and to control for workers in the general economy in comparable roles.

NERA's quantitative analysis found that our actual pay levels for ATCO, ATCE and STAR were within the range of modelled benchmarks for the market pay of comparable roles. Although actual pay levels for ATSAs were above the estimated market benchmarks, NERA concluded that this may be because ATSA comparators did not adequately reflect the safety critical and operational elements of the ATSA role.

NERA also noted that their estimate of the market compensation is likely to be understated, as the model had not been adjusted for factors specific to us. These include the effect on pay levels of a non-liquid labour market for operational staff, a highly unionised workforce combined with the high social cost of strike action, the shift nature of the work which includes antisocial hours, and the specific skill set demonstrated through a rigorous recruitment and training process.

NERA's full report is available alongside this plan document.

Staff cost benchmarking for non-operational support staff and management

We have compared the midpoint for each negotiated grade level and the Hay industry and service sector median for the same job size. Results show that, on the whole, basic pay for the PCG and MSG grades across the corporate areas appear to be positioned between 90 and 110% of market median. This indicates that pay levels for our corporate area staff are broadly in line with market practice in the areas where there is a liquid skills market, demonstrating the success of our efforts to manage pay levels effectively.

We benefit from long service, meaning lower recruitment and turnover costs. Despite this historical low attrition, changes to both the pension tax environment and our organisational structures have required that we ensure that we can attract and retain highly skilled employees in senior and professional grades. These are people who are key to delivering our strategic plans and whose skills are in high demand externally.

The PCG total cash position is slightly higher when compared with the Hay market, which is reflective of incentive payments that have paid out typically higher than the market. This reflects the achievement of stretching company performance targets, which has resulted in strong performance in recent years.

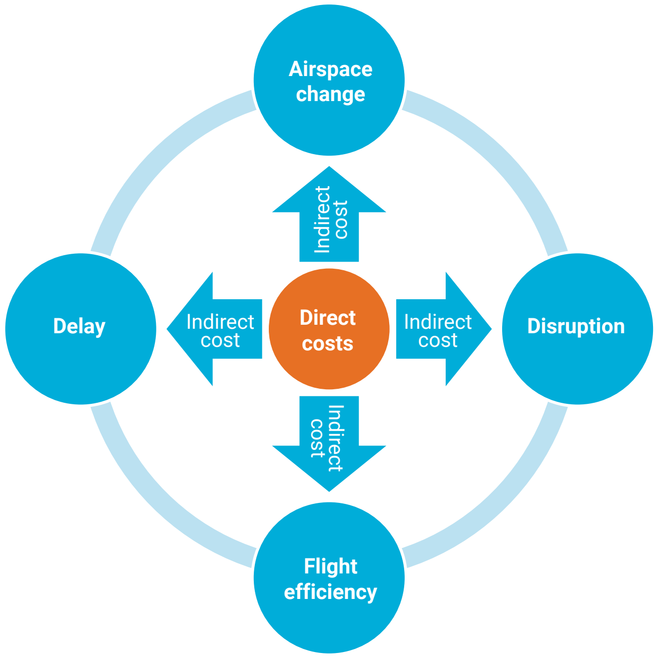
The cost efficiency of our plan

Our approach

We are committed to making our costs as efficient as possible. Our plan for RP3 builds on the significant price reductions that we have delivered during the RP2 period, delivering further price savings to customers. We also believe strongly that the cost efficiency of our plan needs to take account of both the direct costs that we incur and the indirect costs that our customers incur relating to the effectiveness of our operational performance. Our objective is to balance these types of cost in a way that produces the most efficient total cost for airlines.

The diagram to the right illustrates the relationship between our direct costs and the indirect costs borne by our customers. The latter is driven by the nature and level of delay, the extent of progress on airspace modernisation, the quality of our employee relations and the degree to which we can provide fuel efficient flights.

The four headings represent the areas where we believe that our performance can have the most material impact on the costs incurred by airlines.



Delay

- > Delay is a significant factor for our customers. However, delay attributable to us in 2017 contributed only a small part (around 6%) of overall delay to airlines, see Appendix F for more details. However, when noticeable en route delay occurs, it leads quickly to enquiries from customers even when the numbers of aircraft involved are relatively small when judged against our overall performance targets. While we are focused on delay attributable to us, our investments in airspace and technology can help to reduce other contributors to delay in time, for example, help to reduce start up and taxi out time inefficiencies. We can also help to optimise airspace design in conjunction with airport-led changes to low level airspace.
- > We can reduce the risk of asymmetric cost of delays to our customers by ensuring that our resource levels are adequate and resilient i.e. the marginal cost of providing additional resources is significantly less than the cost of avoided delay. In addition, we can help to influence delay levels in areas for which we do not have direct responsibility. These include: start up delay and excess taxi time through investment in modernisation of airspace and procedures; and developing queue/network management tools and techniques, in conjunction with airport-led changes to low level airspace designs.

Airspace change

- > Airspace modernisation, for example, London Airspace Management Programme (LAMP) will deliver significant customer benefits in additional capacity, greater flight efficiency and reduced delay and costs.
- > By ensuring that we have sufficient resources to deliver the airspace changes as well as our next generation of systems, we will reduce the risk of delaying programmes like LAMP and therefore avoid indirect costs to our customers. Our resources will need to include dual running of legacy and replacement systems for a time and training.

Disruption

- > The impact of industrial action across Europe in 2016 was estimated by Airlines for Europe (A4E) at more than €1.6bn[1]. Industry estimates of the impact on airlines of one day of airspace closure vary between around £100m and £150m per day[2]. Using a conservative estimate, a day's disruption in the UK of around £50m would equate to 2% of our cost base across the whole RP3 period.

[1] Study conducted by PwC on behalf of Airlines for Europe (€1.6bn relates to estimated impact on EU GDP for first nine months of 2016) https://a4e.eu/wp-content/uploads/2016/10/A4E-ATC-Strikes-Economic-Impact-Summary-Final-Updated.pdf.
[2] Estimates from IATA https://www.iata.org/whatwedo/Documents/economics/Volcanic-Ash-Plume-May2010.pdf and Centre for Economics and Business Research based on Icelandic volcanic disruption in 2010.

- Avoiding industrial action is the primary imperative of A4E, and we take it very seriously. We have a strong employee relations record with no formal industrial action since 1982. In order to maintain this, we need to continue to have levels of pay and terms and conditions that are reasonable, and staffing levels that are both efficient and sustainable.

Flight efficiency

- Airspace modernisation, such as LAMP, and oceanic investments will deliver the most significant fuel savings for airlines. However, additional savings will also be delivered tactically by our operational staff, for example, by providing more fuel efficient flights and addressing hot spots.
- By ensuring that we have sufficient operational resources, we can continue to drive and deliver these tactical savings.

How we will deliver further cost efficiency

Our RP3 business plan builds on very significant operating cost savings that we have made since our Public Private Partnership (PPP). Over this time we have reduced our controllable underlying operating costs by around 40% in real terms, including major programmes such as centre consolidation and voluntary redundancy, and efficiencies from new tools such as iFACTS. This enabled significant price reductions in recent years (a real term reduction of around 27% across RP2). When 2018 unit rates were set, we had the second lowest of the five largest air navigation service providers (ANSP) in Europe.

Building on this, we plan further operating cost efficiencies amounting to £70m over the RP3 period. These savings relate largely to managing and maintaining the new systems that we are implementing in RP2 and RP3. Most of these have yet to be secured and are included in our plan at our risk. These are summarised below.

Technical service operations

- A revised management structure that is aligned to our single operation vision will rationalise our technical service teams. This will optimise our team structures and make most efficient use of our resources. It will allow us to address tasks flexibly throughout the operation, rather than being tied to specific sites or systems. This should make us more efficient from early RP3.
- Transition from an asset based operation to a service based operation will produce savings through the introduction of a more generic, rather than system specific, IT skill set for key tasks, such as 24/7 monitoring and issue resolution. This approach will allow increased flexibility and efficiency in our ways of working and is assumed to bring both headcount savings and a reduction in average salaries.
- We will use contractors in technical services where possible, for work that is temporary or short term. This reduces overall cost as well as ensuring flexibility in the workforce to match changing demand of level and skill patterns. In addition, we assume the use of lower graded roles in place of historically higher graded ones for the same work, where appropriate to do so.

Programmes

- The introduction of the Portfolio, Programme and Project Office (P3O) will shift the focus of programmes from delivering technology to the delivery of benefits. This allows us to optimise the portfolio and ensure that we maintain the right balance of investment in terms of sustainment, deliver the transformed platform and realise targeted customer benefits.
- The introduction of new approaches that enable specific system and application updates with minimal impact on other systems or applications, so reducing test and validation times and costs. The architecture of our new platform is designed to allow more flexibility in how we can maintain and update individual components. While these solutions are not yet in place, we are assuming benefits from this from early in RP3, which will fully mature on completion of DP Lower in 2022.

Training services

- Revisions to the end-to-end process are planned, which will reduce the time it currently takes to complete it, from the receipt of applications, to the start of training at the college and deployment in the units. This reduction in end-to-end training timescales will not only reduce cost, but also reduce risk in meeting our operational requirements for newly trained controllers. A change to the recruitment and selection model, and efficiencies from the re-engineering of the process, are also factored into the business plan.

Operational service – increased automation

> The increased automation of routine tasks is planned to realise efficiencies in a range of functions that support delivery of the operational service.

Operational service – combined operation

> The move of the Swanwick area control and terminal control operations into a common operations room, using increasingly common equipment, tools and methods of operation, is planned to realise efficiencies in the running of the operation, both in the supervision and day-to-day deployment of operational and support staff.

Operational service – organisational design

> The transition to standardised ways of working and alignment of roles and functions is planned to realise cost efficiencies and increased output within some of the teams.

Operational service – flexibility

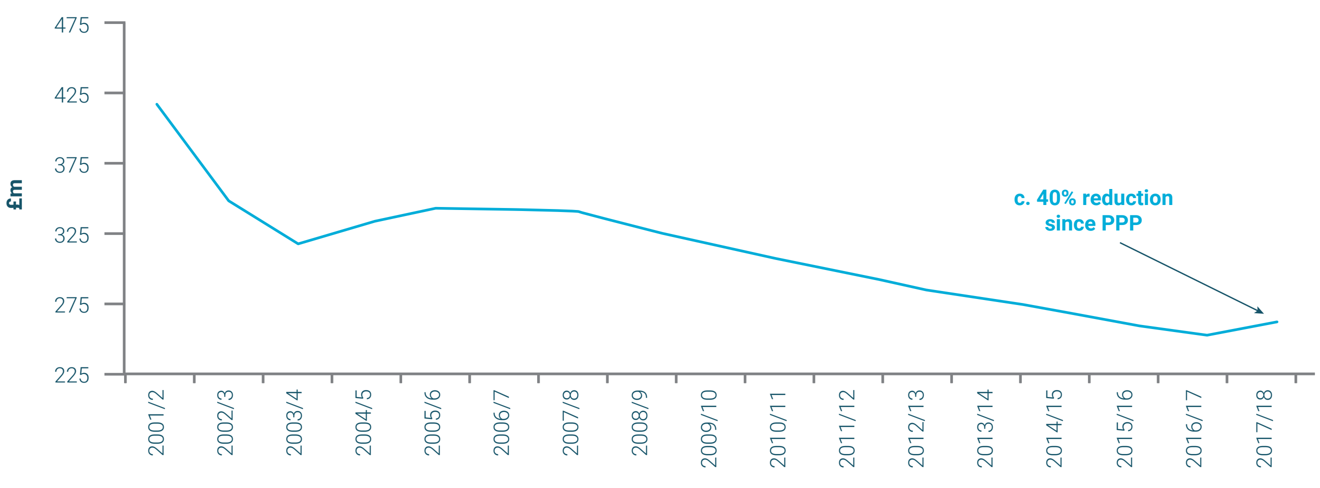
> The introduction of new technology during RP2 through the long term investment plan (LTIP) provides the foundation on which new operational concepts can be built in RP3. These developments will allow us to respond more flexibly to changes in traffic volumes and routes and so be more efficient in meeting customer demand.

Not only are we focused on delivering the above cost efficiencies, which have been included in our plan at risk, but we also expect to deliver increased productivity through our operation. This additional productivity is critical in allowing us to deliver the service quality outcomes in our plan and the capacity requirements that additional traffic will bring. See Appendix K for more details.

Post privatisation performance: opex

Since PPP in 2001, we have made a real terms reduction in our controllable underlying opex approaching 40%. This is shown in the chart below.

Real underlying operating costs (2008/09 prices)

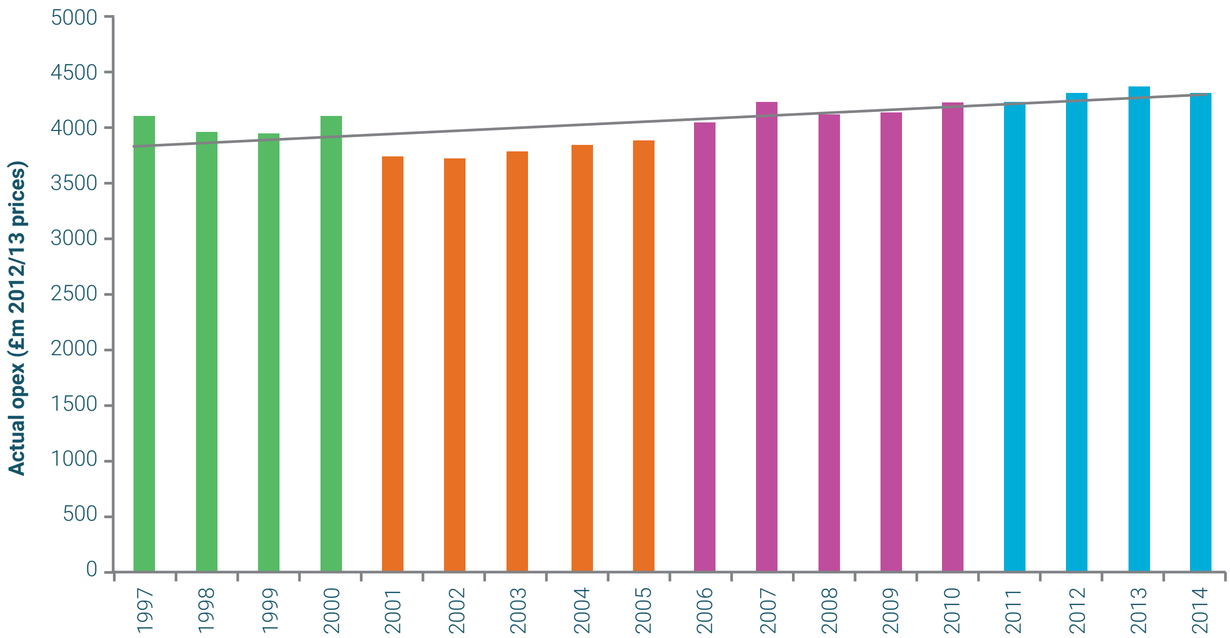


This was achieved through large reductions in the years immediately after privatisation, followed by additional more gradual reductions. In recent years, underlying opex has remained relatively flat despite increases in traffic.

This is consistent with the performance of other UK regulated companies in the years following the introduction of price control regulation. Evidence indicates that UK regulated companies tend to reach the efficient opex frontier after initial price control periods, and that there are then more limited opportunities to make subsequent opex efficiencies.

For example, Scottish Water reduced opex in its first five-year price control period (2002 – 2006), achieving nearly a 40% reduction. Since then the regulator, the Scottish Water Industry Commissioner, has reported that Scottish Water's operating costs have remained relatively flat at around £300m. There is a similar trend in other UK water companies, and since 1997 there is evidence that shows that regulated companies in the water sector do not realise opex cost reductions beyond the first and second price control periods. In fact, as shown in the chart below, actual opex has increased slightly in recent price control periods.

Water companies operating cost performance

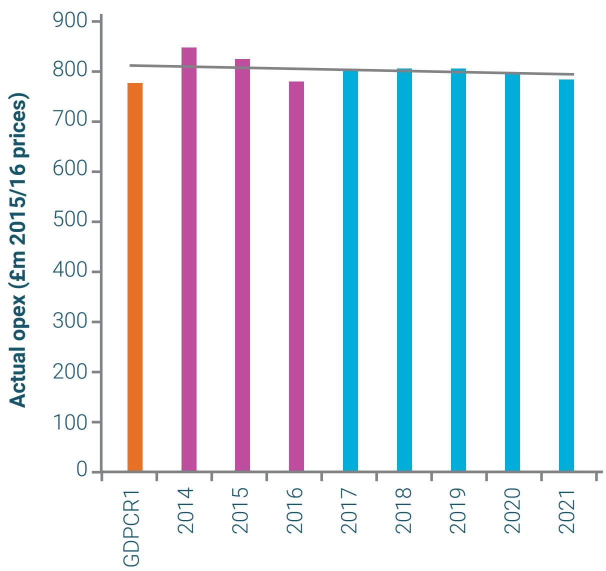


Opex in the UK energy and gas sectors has a similar trend. On average, opex is relatively flat in current price controls, as shown in the charts below.

Electricity and gas companies operating cost performance

Cost efficiency: electricity sector

Cost efficiency: gas sector



The elasticity of our costs

Our determined cost base is largely fixed in nature during a five-year reference period. We estimate that, in the medium term, between 7.5% - 15% is variable i.e. affected by changes in traffic volume. The remaining 85%+ is fixed, and does not vary with changes in traffic. This reflects the fixed infrastructure nature of our business which applies to people as well as the assets they operate.

The table below analyses the key components of our cost base, excluding regulatory return*, to show our estimate of the extent to which it varies in relation to changes in traffic volume, at the high end of the range.

Our cost elasticity

2017 CPI prices (calendar year) £m	Fixed	Variable	Fixed %	Variable %
Staff costs	958	319	75%	25%
Pensions	329	86	80%	20%
Non-staff costs	790	89	90%	10%
Regulatory depreciation	733	39	95%	5%
Non-regulatory income	(371)	(93)	80%	20%
Total	2,439	440	85%	15%

* Regulatory return is excluded because this will reduce or increase to the extent that traffic related changes in revenue exceed or are less than changes in cost.

> Staff costs: Approximately 50% of staff cost relates to operational staff. In the short term, operational staff numbers do not vary materially and their relationship to traffic is non-linear. Numbers can be increased through recruitment and training after a lead time of around three years. Numbers can also be reduced through voluntary redundancy, but not quickly. First, numbers leaving through voluntary redundancy are not under our direct control. Second, we have to exercise a degree of caution before launching such a programme as we need to have sufficient certainty that any related traffic downturn is going to be sustained rather than temporary. It could take time to obtain such assurance. If we release operational resources, only to be faced by a rebound in traffic, this could be very costly in terms of delay because of the around three-year lead time for recruiting and training new controllers.

> Around 50% of staff cost relates to non-operational staff including safety, engineering and support functions. These do not vary to any material degree with traffic changes.

> Pensions: These costs largely follow staff cost trends, apart from the element of pension cost that relates to deficit repair contributions for the defined benefit scheme. Such costs are fixed until contribution schedules are reset triennially. For this reason, pension costs are affected by traffic to a slightly lesser extent than other staff costs.

> Non-staff cost: The majority relates to fixed infrastructure cost including facilities management, buildings, systems and third party maintenance contracts. These do not vary with changes in traffic volume. A small element, including costs paid to the Ministry of Defence (MOD) for managing traffic outside of controlled airspace, is variable.

> Regulatory depreciation: This cost relates mainly to the depreciation of assets that were added before the start of RP3. This is completely fixed in nature. The element of which relates to capital expenditure incurred during RP3 is also largely fixed. Such costs will not be driven significantly by changes in traffic volume, as they also relate to infrastructure investments and sustainment programmes.

> Non-regulatory income: Around 50% of the non-regulatory income relates to the contract that we have with the MOD future military area radar services. This is a fixed price contract and is not linked to traffic volume. While some other sources of income have a variable element, they are typically more fixed than variable in nature.

Implications for cost of capital

As explained above, we estimate that a maximum of 15% of our determined cost base is variable, and this only holds true in the medium term. This means that under the existing traffic risk sharing mechanism, our exposure to demand risk should be reflected in the cost of capital.

In CAP 1625, the CAA noted that, if the Single European Sky (SES) regulatory framework provided sufficient flexibility, the traffic risk sharing mechanisms could be aligned with our operating expenditure elasticity, to effectively neutralise the risk. We understand this to mean that the risk sharing keys could be adjusted so that we bear a risk that is equivalent to the proportion of variable costs to the total cost base.

Although the risk sharing keys could be adjusted so that the risk is neutralised in the medium term, we would still be exposed to risk in the short term for the reasons described above. As such, the cost of capital should still take into account our exposure to demand risk.

Relationship between operating costs and inflation

Based on SES regulations, our revenues during RP3 are expected to flex each year in relation to changes in consumer price index (CPI) inflation. As such, we will gain or lose if the company's operating cost base grows or reduces more quickly or slowly than the rate of CPI inflation. At a high level our operating cost base is affected by inflation in the following ways:

> Staff cost: Our workforce is heavily unionised and the company undertakes significant consultation and negotiation on pay with staff and trade union representatives. The value of the CPI index typically forms a key input into pay negotiations, but is only one element of pay settlements. When CPI is low, it is particularly challenging for us to agree a pay deal that is in line with, or close to CPI. If CPI was to fall below zero, a pure CPI based pay deal would not be feasible.

> Non-staff cost: Our key non-staff costs relate to a range of third party contracts associated largely with the maintenance and sustainment of our infrastructure. Only a small portion - around 10-15% of third party contracts - is indexed relative to CPI. Instead, we usually negotiate fixed price contracts that range from five to 15 years in duration. When contracts are renewed, prices tend to catch up to reflect changes in inflation. After an initial step change (up or down), a renewed contract would then be fixed for the contract period. As such, we bear an inflation risk relating to most of our third party non-staff operating cost. This is because, if inflation is lower than assumed, our revenues will reduce but most non-staff costs will not.

> Utility costs: Our annual utility cost is around £7m p.a. We hedge the commodity proportion of this cost (around 40%), which typically provides an element of price certainty for the next financial year, although we purchase it up to 36 months in advance. Utility costs are driven far more by changes in market conditions, oil prices and third party charges/taxes than changes in CPI inflation levels. Therefore, the element of our cost base that relates to utility costs can vary significantly and will rise or fall far more than the movement in the CPI index.

This analysis has led us to link our cost base to CPI where this is a good indicator of likely changes and to use other estimates where it is not.

Impact on our plan outcomes of potential cost reductions that may result from the EC Performance Review Body's recommendations

The CAA has asked us to describe the impact on our service quality, resilience and delivery plans if we were required to deliver the determined unit cost (DUC) reductions for RP3 proposed by the EC's Performance Review Body (PRB). The PRB published its final recommendations for RP3 targets on 30 September 2018, and we have made this DUC assessment for our en route service relative to these proposed targets. Our initial overall assessment (see below) is that the PRB cost efficiency proposed target would provide insufficient funding for resources to provide, or in some cases only partially provide, a satisfactory standard of core and non-core services.

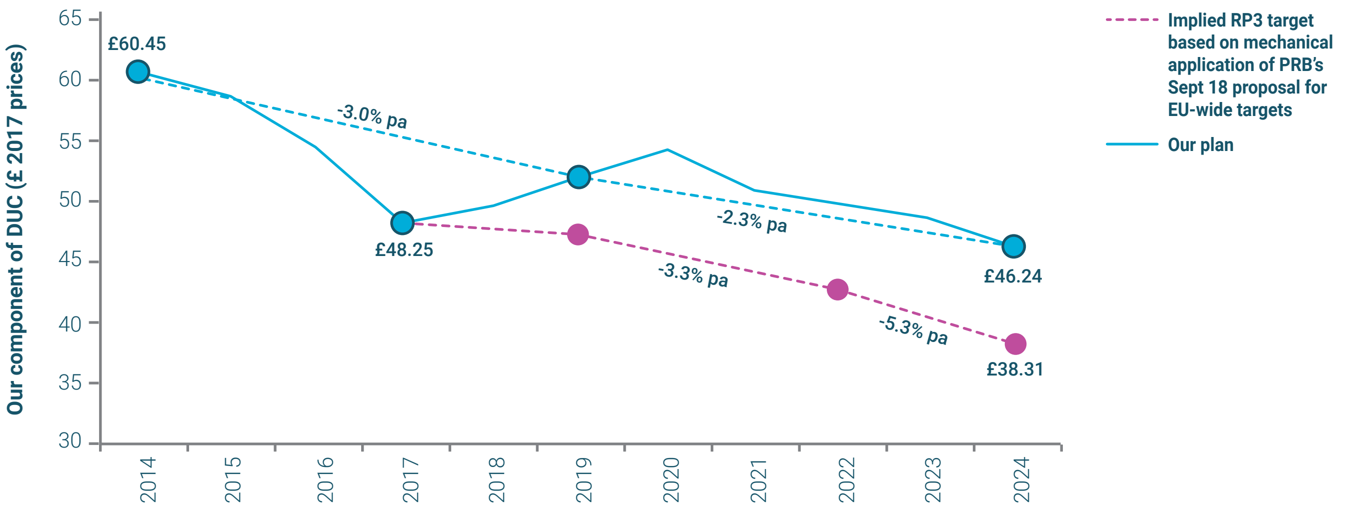
The CAA's assessment of our service performance against our Licence obligations must take proper account of the outcome of the business plan process and the trade-offs made as part of it to reflect customers' priorities and CAA's determinations. Compliance with the PRB's September 2018 proposed cost efficiency target would mean that we would not have enough resources to provide the level of service and resilience proposed in our plan, and to deliver other customer requirements. If the CAA imposed this target upon us in its price control determination, then we would need to recast the entire plan and obtain assurance from the CAA that the resulting fall in service performance and resilience would not represent a breach of Licence. As outlined below, our initial view of the consequences of being compelled to achieve the proposed PRB target for cost efficiency is that we would be in this position. We will need to revisit this when the final target is known.

Comparison between our DUC reductions and PRB's EU-wide methodology

The chart below shows the development of the DUC for our en route service in our business plan (blue line). This equates to a 2.3% p.a. real reduction in DUC during the RP3 period (2019 – 2024), which builds on a 3.0% p.a. reduction in DUC during RP2. By 2024, our DUC is projected to reduce to £46.24 in 2017 prices, the lowest point since PPP.

The methodology used by the PRB in September 2018 within the recommendations made for EU-wide cost efficiency targets, is shown on the purple dotted line. The PRB approach takes 2017 actual as a base year and creates a 2019 start point from this. Relative to the 2019 start point, real DUC reductions of 3.3% p.a. are assumed for the first three years of RP3, and 5.3% p.a. is assumed for the last two years of RP3. If the same methodology was applied mechanically to us, the implied DUC value for 2024 would be £38.31 in 2017 prices.

Comparison between our DUC reductions and PRB's EU-wide methodology



Quantifying the PRB's cost reduction if applied to our en route service

If we had to meet the levels of DUC efficiency implied by the PRB's September 2018 guidance, we would need to remove around £100m p.a. from our determined cost base. This is equivalent to around 16% of our costs.

In order to assess how a requirement to meet this target would affect us, we need to take into account certain fixed elements of our determined cost base which cannot be adjusted. For example, the majority of regulatory depreciation, which makes up a quarter of determined costs, relates to the recovery of investment costs that we have made before the start of RP3. Although it may be possible to reduce depreciation costs during RP3 by extending the regulatory depreciation period to more than 15 years, a change to this assumption would risk creating a significant gap between the average expected useful life of assets and the period over which costs are recovered, and we would not support this.

In our initial assessment, we have made no change to the level of assumed non-regulatory income, by making a simplifying, and fairly optimistic, assumption that there would be no material change in the value of our revenue contracts if our plans had to be adjusted to reflect the PRB's proposals. We have also made no adjustment to pay levels because the benchmarking studies we have undertaken have shown the pay levels in our plan are broadly in line with market comparators. Similarly, our plan includes a regulatory return, which is evidence based and reflects an efficient cost of capital, and which has not been adjusted in this assessment.

Applying the cuts uniformly

Recognising the fixed nature of the factors above, we have calculated that it would be necessary to reduce all other costs - operating costs, pension costs and capital expenditure - by around 18% to meet the PRB's targets. A large element of these savings would require staff cost savings, and we would need to incur some restructuring costs. For this reason, we estimate that a gross cost saving of 20% would be required to realise the 18% net saving (i.e. a 20% gross saving less 2% of additional restructuring costs). Our initial assessment regarding the likely size of the restructuring cost recognises that a portion of staff cost reduction would be realised by not filling new posts, rather than removing existing roles.

If applied uniformly across all areas, a 20% saving in cost would require a reduction of around 700 staff, relative to our plan, of which 200 would be operational controllers. It would require a reduction of around 175 staff in our technical services team, 175 staff in operational support roles, and further reductions of 150 staff in trainee numbers (50) and support functions (100).

This would involve significant company restructuring, almost certainly requiring a large compulsory redundancy programme, adversely affecting employee relations. We would expect to see widespread industrial action if we had to take this action. Our RP3 capital programme, and the level of non-staff expenditure, would also reduce by around 20% if these cuts were applied in a uniform manner.

Applying the cuts in an attempt to protect our day-to-day service

If we were forced to make the scale of cuts described above, our priority would be to protect our day-to-day service as far as possible. However, due to the overall scale of cost reduction required, it would still be necessary to significantly reduce controller numbers by around 100 (10%) compared to our current plan. Therefore, deeper cuts would be required in other areas of around 25% in technical services, 25% in operational support staff and 25% in support functions in order to realise the overall 20% gross saving.

We estimate that our RP3 capital programme would need to reduce in size by around 20%, due to the need to reduce our costs generally, and also to the lack of staff across the whole business, in particular controllers, to support project delivery plans. The value of our non-staff costs, which include third party maintenance contracts in support of key operational assets and systems, would need to reduce by around 20%, which is approximately £35m p.a.

In order to provide even the most basic ATC service, there are certain costs that we simply cannot avoid incurring. These include running and sustaining our existing ATC infrastructure, including our buildings, and providing a minimum level of staffing in order to operate safely a service which is open 24 hours a day, 365 days a year. The fixity of this cost means that, in order to reduce costs by 20% overall, an even higher proportion of cuts needs to come from other areas whose costs would have to be reduced. The implications of this are described below.

Implications for service quality, resilience and programme delivery

Even if we aimed to protect our day-to-day service as far as possible, changes of the scale described above would have far reaching impacts on the levels of service we provide to our customers. The impact would affect our daily ATC service; our levels of technical and operational resilience; our ability to complete our technology transformation and airspace modernisation programmes; and our preparations for RP4.

The impact of cuts to operational staffing

A reduction of around 100 operational controllers would require us to significantly restrict the number of positions that could be opened each day. As our operation is already very efficient, as recognised by ACE benchmarking, reductions in headcount would necessarily affect the level of capacity that we could provide.

Our priority would be to provide a safe service. As such, even if we were to prioritise the service during peak hours, we would need to impose severe restrictions on the number of aircraft permitted to operate in UK airspace, leading to very significant levels of delay on the ground and additional airborne holding. Forecast traffic growth during RP3 and RP4 would worsen this situation, going forward.

It is likely that a reduction of 100 controllers would, on its own, increase delay to over one minute per flight compared to our plan assumption, before taking into account any effects of industrial action and loss of goodwill. The reduction in operational support staff would worsen this situation significantly because it would reduce the efficiency of the controllers.

The operational staff reductions described above - combined with employee relations issues and expected industrial action which would further increase delay - lead us to believe that this would be unacceptable to customers. Based on PRB methodology, as set out in Appendix F, the incremental cost of one minute of additional delay per flight to airlines, valued at just over £4m per second, would be above £240m p.a. This would far exceed any direct cost savings to airlines from the reductions in prices implied by the PRB targets, if applied in a mechanical way.

The combined reduction in operational controllers and operational support staff would make it impossible to deliver our current change programme for RP3. The implementation of technology change, and the design and implementation of airspace modernisation, relies on controllers being available to support colleagues in established engineering and specialist development functions. The regular release of controllers to undertake training on new systems and airspace changes such as LAMP would simply not be possible, diminishing and probably even removing benefits from a number of our most important investments.

The implications of the cuts described above would not only affect RP3. Due to the lead times in recruiting, training and validating our operational controllers, we estimate that it would not be possible to recover our operational performance to the levels we provide today until the end of RP4 at the earliest, even if we were provided with all of the necessary resources to do so. Cuts to our costs in RP3 would have both short term and long term implications.

The impact of cuts to technical services staffing and third party contracts

A reduction of around 250 staff within technical services, combined with reductions in third party non-staff costs, would have a very significant impact on the service provided to customers, both in terms of the resilience of our day-to-day service and our ability to support future investment plans.

From a day-to-day perspective, reductions in engineering resources, combined with cuts to the scope of asset management activities, would greatly increase the risk of systems failures. The level of regular preventative maintenance would need to be cut back significantly and our ability to respond to events would be reduced. The delay to our investment programme, described in the section below, would require us to maintain existing ATM systems far beyond their current end of life state, with an increased risk of failure. This would result in ATM delays occurring more regularly, and lasting longer, for our customers. This outcome would be unacceptable to the travelling public, government and other stakeholders.

Our plans to evolve our service in RP3 would also be significantly affected by cuts to the technical services team. Our ability to assure the safety of our ATM systems would reduce, affecting the number of new systems we could introduce during RP3. We would have fewer resources to support the annual SIP process, making it impossible to deliver the enhanced SIP reporting, which we discussed during the RP3 customer consultation. The effectiveness of our new investment teams would also be greatly diminished. These deliver best practice programme management activities, tracking and delivering benefits for our customers, and include our P3O.

The impact of cuts to our investment plan

The impact of around 20% reduction in the cost of our investment plan would be very significant for both the delivery of key customer priorities and the resilience of our current and future operational systems during RP3.

Key programmes of work, including the most important component of our airspace modernisation programme, LAMP, and the final harmonisation of our operational systems would not be able to start until RP4. The delivery of the planned changes to remove our oldest systems would also be deferred until late RP3, and the programme to replace our ageing radar infrastructure would also move into the next reference period.

Considerable additional risk would be borne across our current operational systems, which would have to operate way beyond their anticipated lives leading to a likely increase in failure rate and reduction in underlying technical resilience. The need to continue to sustain these systems, combined with higher failure rates would further delay the delivery of our future technical platform and impact our ability to manage future capacity demands.

Overall implications

Due to the severely detrimental impact of the cuts described above on levels of service, resilience and programme delivery, we would not be able to support a plan for RP3 which contained the level of reduction in resources required to meet DUC reductions implied by the mechanical application of the PRB's proposals for EU-wide targets. The impact of the cuts would, in our view, make it impossible for us to deliver our Licence obligations.

Factors causing the gap between our plan and the implied EU-wide target

The gap of around16% between the DUC in our business plan for RP3 and the value implied by the mechanical application of the PRB's proposed EU-wide target for RP3 can be analysed as follows:

Factors causing the gap between our plan and the implied EU-wide target

Factor	Difference	Reason
Cost pressures in late RP2	9%	The PRB's target does not take into account the significant additional costs that we have to incur in late RP2 in order to handle higher than forecast traffic and to accelerate our technology plan to modernise airspace as early as possible in line with our customers priorities and requirements.
The rate of RP3 traffic growth	3%	The rate of UK traffic growth forecast for RP3 is around 50% lower than forecast EU-wide growth, making it very challenging to deliver the same level of DUC reductions.
Other factors	4%	UK specific factors such as the impact of accelerated DSESAR expenditure, and the LAMP airspace modernisation programme lead to higher costs for the UK.
Total	16%	

These factors are described below:

> Cost pressures in late RP2: The PRB methodology starts from the actual DUC in 2017 and by 2019, the gap between the level of determined cost implied by the mechanical application of the PRB methodology, and costs in our plan, is around £55m in 2017 prices. The 2017 year is an inappropriate start point for the UK because it represents an unrealistically low cost base. The PRB methodology takes no account of additional resources and costs that we require in 2018 and 2019, relative to the cost base in 2017, in order to provide the level of service and investment that customers require. The additional costs in 2018 and 2019 will not impact prices in those years.

  The around £55m implied gap created by the use of the PRB of 2017 as a start point for RP3 target setting compared to our plan, broadly relates to the following areas:

  – Around £25m: Increases in operational and training resources to meet the challenge of much higher than forecasted traffic growth in RP2 and to handle expected future growth in RP3, while enabling us to deliver a more resilient service, which is a key priority for our customers;

  – Around £20m: Relates to implementation of our accelerated technology change programme, including additional requirements for cyber security and dual running costs; and

  – Around £10m: Relates to costs necessary to support future LAMP delivery and to enhance our ability to maintain the safety of commercial air traffic in controlled airspace from the emerging risk of drones.

> The rate of RP3 traffic growth: The PRB's DUC proposals are based on rates of forecast traffic growth of around 13% for Europe as a whole between 2019 and 2024. This rate of traffic growth is nearly 50% higher than the rate which is forecast for the UK (around 9% between 2019 and 2024). Although higher traffic levels would require us to incur some additional costs, the fixity of our cost base means that most of this traffic growth would reduce unit costs. As such, it is entirely unrealistic for us to make the same cost efficiency % reduction as ANSPs in states that are forecasting much higher forecast growth.

> Other factors: There are a range of other factors which explain the remaining 4% difference between the PRB's implied target and the DUC in our business plan. Key factors include:

  – Acceleration of £160m DSESAR capex from RP3 into RP2: During the RP3 customer consultation, we explained that the acceleration of this capex would increase unit costs and prices by around 2% during RP3 but that it would be neutral over the longer period. By accelerating this expenditure, we have secured additional INEA funding that would not otherwise have been available, and which does not form part of the DUC assessment;

  – Airspace modernisation: The UK has a particular challenge to secure the additional resource and investment that is required to support a major airspace modernisation programme during RP3, including LAMP. This programme is a key customer priority. The UK specific costs associated with this programme must be taken into account;

  – Changes in scope in RP3: In our view, the PRB approach does not make adequate allowance for changing requirements in RP3, including increased cyber protection activities, the need to deal with the emergence of drones, and the UK requirement to invest in future ATM capability (research and development activities) in light of reduced funding from Europe. Also, the technical solution and advanced tools we will operate during RP3 will significantly exceed the capability of legacy systems that were operating in RP2, but will require additional expenditure to support; and

  – Real wage pressure: The EU-wide targets proposed by the PRB do not appear to adequately take into account the pressure on wages in the context of global shortage for ATCOs, the highly skilled operational role they perform, and the fact that there is no alternative for air travel, particularly in the UK.

Further points when assessing cost efficiency

If the cost efficiency of our business plan is to be compared to the approach taken by the PRB in proposing EU-wide targets, the following factors must also be considered:

> Customer requirements and priorities: We have consulted extensively with our customers who have been clear that their priorities are for us to deliver a resilient service, complete our technology transformation programme, and modernise airspace. Our plan has been built to meet our customers' needs while also delivering real annual DUC reductions of 3% in RP2 and 2.3% in RP3. We will simply not be able to satisfy customer requirements if we have to meet DUC targets that are based on the mechanical application of the EU-wide methodology proposed by the PRB;

> Direct and indirect costs: As described earlier in this appendix, the approach we take to cost efficiency is to take into account both the direct costs that we incur and the indirect costs that are borne by our customers. If we have to make material savings in direct costs, compared to our plan, this will increase the risk of airline delay, disruption, reduced flight efficiency and/or failure to deliver key airspace changes. The net impact of this would be higher costs for our customers; and

> Relative efficiency of ANSPs: EU-wide targets should not be applied uniformly to all ANSPs, but should instead recognise that there are wide differences in the relative efficiency of ANSPs. This is shown in the academic study undertaken on behalf of the PRB - our performance exceeds that of most ANSPs in our comparator group, and in recent ACE reports.

Why our business plan is best for customers

Our business plan is designed to meet the needs of our customers. With the resource levels in our plan, we can commit to strong levels of service performance and low levels of delay in RP3. We will also be able to continue with our technical transformation programme, and invest in an extremely challenging airspace modernisation programme during RP3.

We take the requirement to be efficient very seriously. This is evidenced by the significant reductions in price that we have enabled during RP2. Measured in the way that the PRB and EC set cost efficiency targets, our real DUC efficiency during RP2 is forecast to be 3.0% p.a. and we are forecasting a further 2.3% p.a. in RP3.

We are achieving this cost efficiency at the same time as delivering service which is amongst the best in Europe, despite record-breaking levels of traffic. At the same time, we are undertaking a transformational technical change programme, modernising the most complex airspace in Europe, and gearing up for the challenges that we expect to face in RP4. These are our customers' priorities and we would urge the CAA not to put them at risk by applying the EU-wide target methodology to the UK.

Appendix J: ANSP benchmarking

Our cost efficiency performance in comparison to other ANSPs

To ensure accurate and meaningful comparison, it is important to use appropriate comparators and metrics. To that end, we have used data compiled on other large air navigation service providers (ANSP) which share some of our characteristics in terms of traffic volumes and complexity of airspace, to help inform our view on absolute and comparative cost efficiency. We benchmark against: DSNA (France), DFS (Germany), ENAV (Italy) and ENAIRE (Spain). Together we represent the five largest ANSPs in Europe, as widely recognised in benchmarking reports.

There are two data sources available for comparing cost efficiency performance:

> Unit rates: The en route unit rate charged per service unit. Unit rates are published for 39 charging zones, of which 31 are within the European Commission (EC) performance scheme (charges are set on a determined cost basis) while the other eight set charges on a full cost recovery basis; and

> Cost effectiveness and productivity indicators: As produced by the Eurocontrol Performance Review Commission (PRC) in their annual report on air traffic management (ATM) cost effectiveness (ACE). This data source is both credible and robust, with significant validation carried out by the Eurocontrol Performance Review Unit (PRU) to ensure that the data is accurate and consistent. The analysis, covering 38 ANSPs, has been in operation since 2002 and the latest available data is for 2016. Our analysis of ACE data examines NATS[1] relative to other European ANSPs, a simple average of a selected number of ANSPs and, in some instances, relative to the pan-European ATM system as a whole.

A summary of our most recent cost effectiveness performance in comparison to the big five ANSPs is shown below, using the average 2008 – 2016 exchange rate (€1=£0.828).

Performance area	Metric	Performance relative to big five ANSPs
Financial cost effectiveness	ATM/CNS[2] cost (€) per composite flight hour (gate-to-gate)	Best
Financial cost effectiveness	ATM/CNS cost (€) per flight hour (en route)	Second best
Economic cost effectiveness (includes costs of delays)	ATM/CNS plus ATFM delay cost (€) per composite flight hour (gate-to-gate)	Third best
ATCOs in ops employment cost	ATCOs in ops employment cost (€) per ATCO hour in ops (gate-to-gate)	Third best
ATCOs in ops employment cost	ATCOs in ops employment cost (€) per composite flight hour 2008-2015	Best
ATCO productivity	Composite flight hours per ATCO hour in ops	Second best
Support costs	Gate-to-gate support cost (€) per composite flight hour	Second best

[1] The data in the ACE report is aggregated. It comprises both NERL and NSL costs and other elements. It is not possible to isolate NERL's contribution to the NATS performance metrics set out in the ACE report.
[2] Communications, navigation and surveillance.

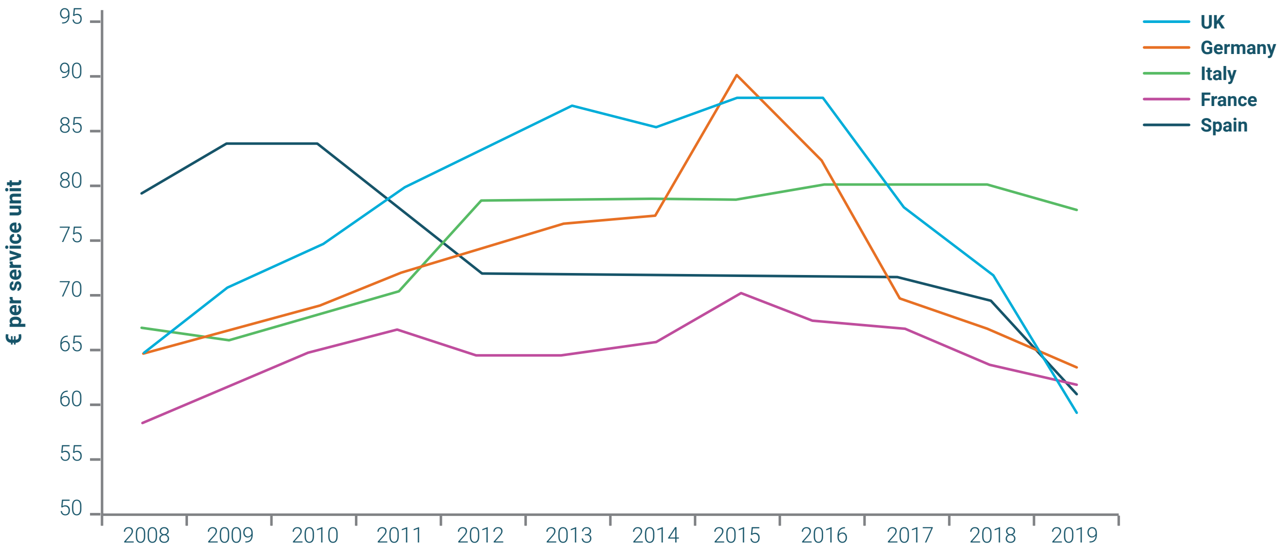
Unit rates

National unit rates

National unit rates do not necessarily give an accurate picture of ANSP cost efficiency because of the impact of differences in operating environment and in cost allocation. However, the UK unit rate has shown a clear downward trend in recent years. Based on the June 2018 cost reporting tables which were submitted to the Central Route Charges Office (CRCO), the 2019 UK unit rate is projected to be the lowest of the big five ANSPs, and ninth in the unit rate league table.

The chart below compares the UK unit rate since 2008 with the four other largest states in the Eurocontrol charging system – France, Germany, Italy and Spain – the respective ANSPs are DSNA, DFS, ENAV and ENAIRE. The five largest states accounted for 43% of total service units recorded in 2017, the most recent year for which a confirmed figure is available. The starting point of 2008 was selected since a peak level of traffic was recorded during that year, before the subsequent impact on traffic from the global financial crisis. For comparability, the UK figures are expressed in € at the average exchange rate between January 2008 and December 2017 (€1=£0.830).

National unit rates 2008-2018, with 2019 projection (€ per service unit)



In comparing national unit rates it is important to take account of differences between states. In particular:

> The UK has comparatively high airspace complexity. Currently we handle around 2.5m flights every year. Of those, over 1.2m arrive at or depart from one of the five main London airports. This means that over 3,200 flights arrive or depart on average every day from six runways, transiting through the complex south east UK airspace. Further detail on complexity is provided below; and

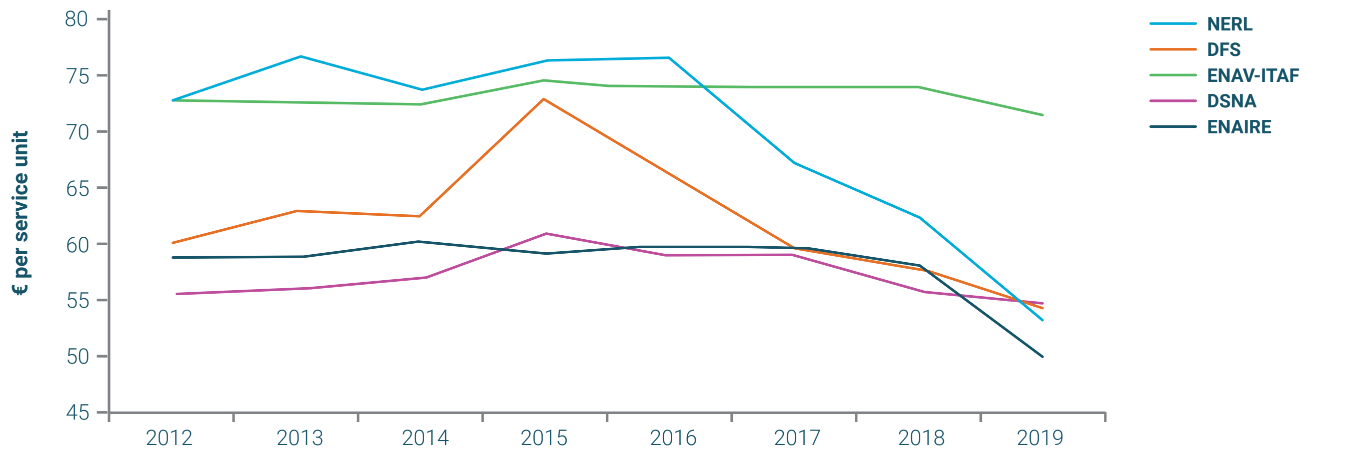
> The impact on UK operations (and costs) from day-to-day variation in the location of North Atlantic tracks due to the position of the jet stream.

In addition, the extent of state support can vary between states. For example, since 2017, the German government has provided a subsidy for pension costs that reduces the German national unit rate.

ANSP unit rates

Unit rates for the ANSP element of the national unit rate have been available since the start of the EC Performance Scheme in 2012. Our unit rate has reduced substantially since 2016. If the projections in the June 2018 cost reporting tables submitted to the CRCO are confirmed in November, then we will have the second lowest rate of the big five ANSPs, a significant improvement from our position in 2012 - 2016. This reduction has been achieved through efficiencies (as set out in the RP2 UK-Ireland Performance Plan) and adjustments for traffic and inflation. For comparability, the UK figures are expressed in € at the average exchange rate between January 2008 and December 2017 (€1=£0.830).

ANSP unit rates 2012-2018, with 2019 projection (€ per service unit)



Cost effectiveness and productivity

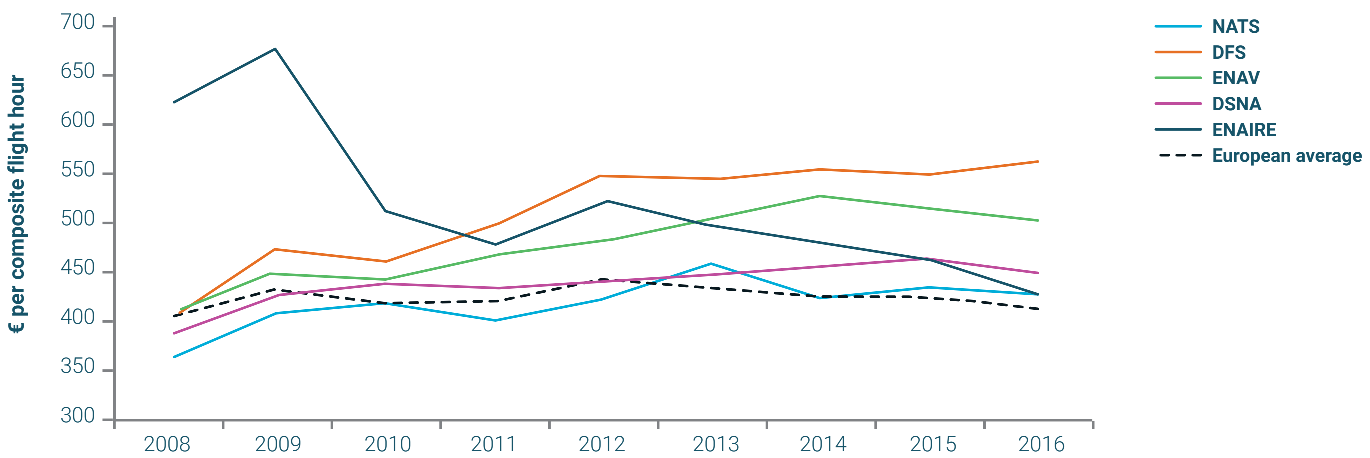
Financial cost effectiveness – gate-to-gate

Our unit cost, at both gate-to-gate and en route level, also compares favourably. In 2016, we had the lowest unit cost amongst the five largest ANSPs for the gate-to-gate level, and the fourth lowest at the en route level, using the average 2008 - 2016 exchange rate (€1=£0.828).

Most of the PRC's analysis is carried out on a gate-to-gate basis, this avoids any distortion from differences between ANSPs in how they allocate costs between the provision of en route and terminal ANS. The time period selected for this analysis is 2008 to 2016. 2008 represents the end of a period in which there were significant peaks in traffic volumes and, as noted earlier, 2016 is the most recent year for which published ACE data is available. As a further aid to comparability, avoiding any possible distortion from the impact of different rates of inflation in different states, the analysis is presented in nominal terms (consistent with the ACE source data).

The chart below compares the overall gate-to-gate cost effectiveness of the five largest ANSPs during 2008 - 2016, in terms of total ATM/communications, navigation and surveillance (CNS) costs per composite flight-hour (an output metric that combines en route flight hours and terminal movements into a single figure). In 2016, the five largest ANSPs accounted for some 57% of total ATM/CNS costs and 50% of traffic (in respect of composite flight hours).

ATM/CNS cost (€) per composite flight hour 2008 - 2016 (gate-to-gate)

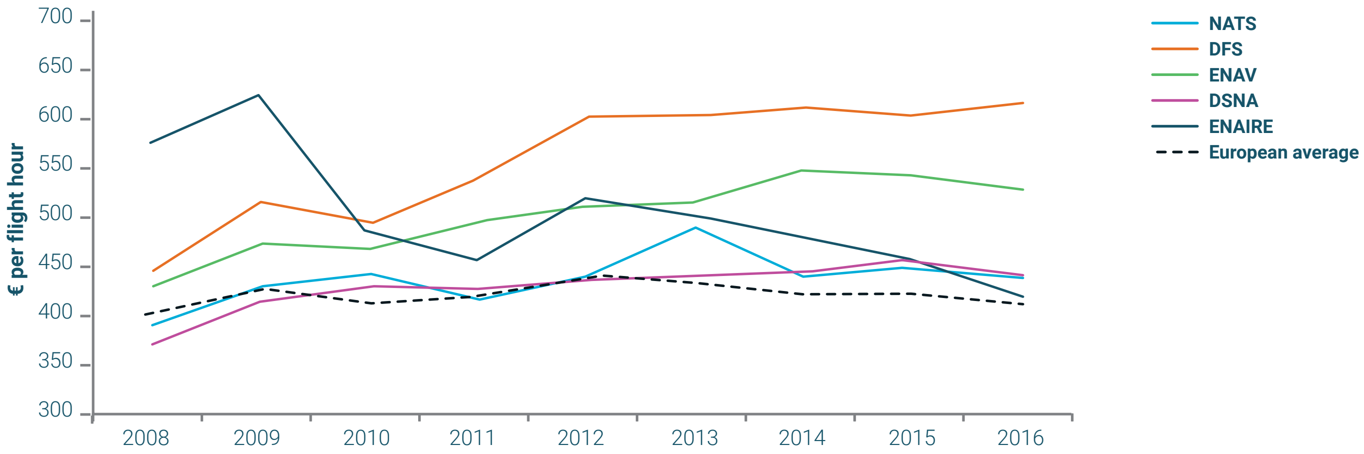


It can be seen that our overall cost effectiveness performance has been consistently strong in comparison with the other four large ANSPs.

Financial cost effectiveness – en route

Overall financial cost effectiveness for the five largest ANSPs can also be compared at en route level, as shown in the chart below. Again, our figures were converted from £ to € using the average exchange rate during the period shown.

ATM/CNS cost (€) per flight hour 2008 - 2016 (en route)

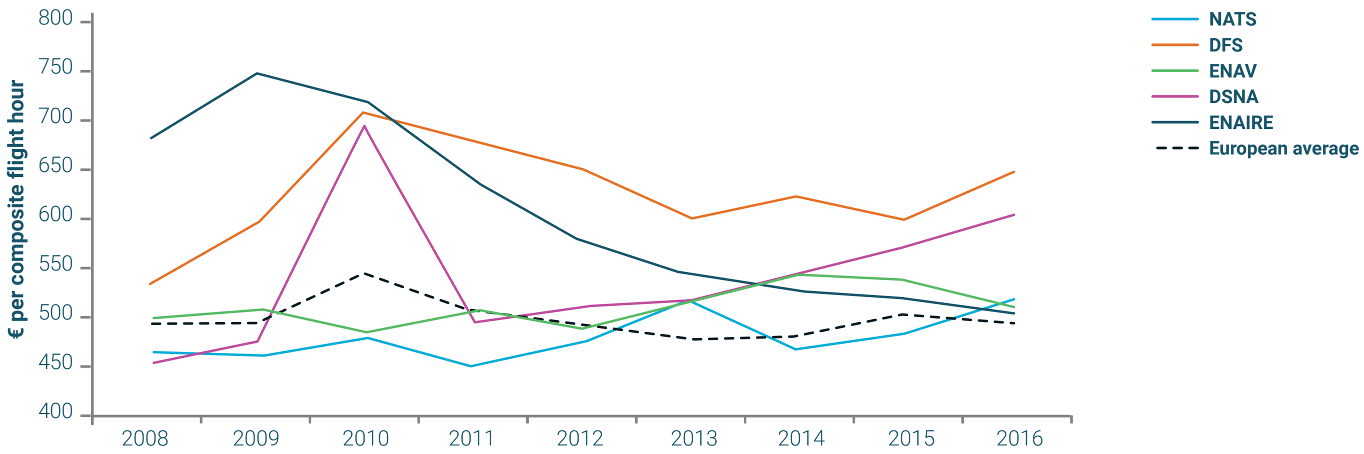


Our en route unit cost has consistently been towards the lower end of the distribution of the five largest ANSPs.

Economic cost effectiveness

In addition to their assessment of financial cost effectiveness, the PRC publishes an indicator of what they term economic cost effectiveness at gate-to-gate level, including the cost of air traffic flow management (ATFM) delays (evaluated using a methodology developed by the University of Westminster). The comparative performance of the five largest ANSPs during 2008 - 2016 is shown in the chart below.

ATM/CNS plus ATFM delay cost (€) per composite flight hour 2008 - 2016 (gate-to-gate)



During the periods 2009 - 2012 and 2014 - 2015 we had the lowest economic unit cost amongst the five largest ANSPs. It is worth noting that despite having a similar traffic complexity score as DFS, our economic unit cost is significantly lower. In 2016, our economic unit cost was comparable with ENAV and ENAIRE, which operate in substantially less complex airspace.

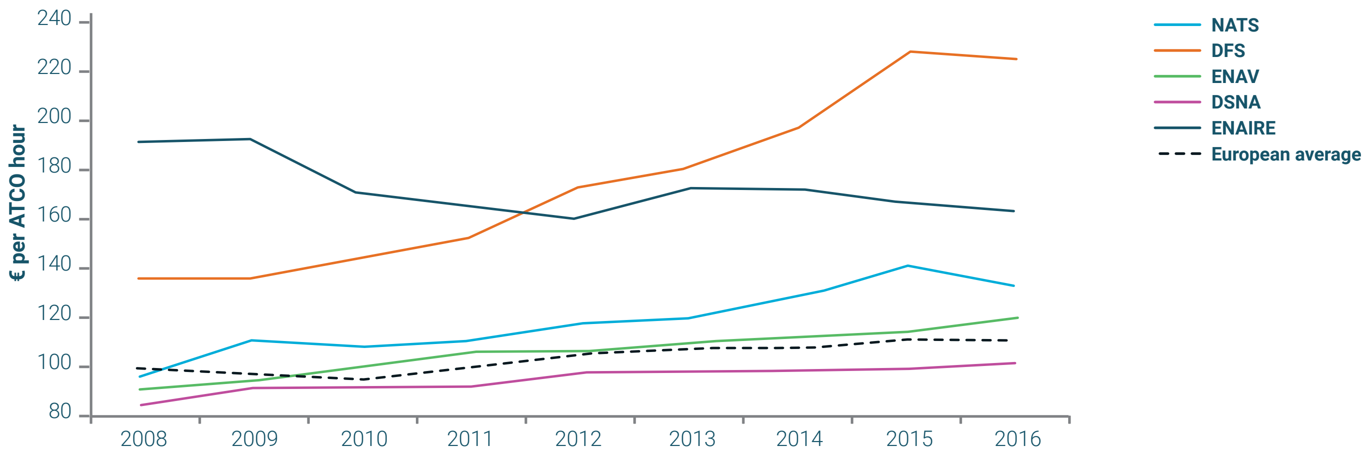
ATCO cost efficiency

Air traffic control officers (ATCO) in operations accounted for 32% of total ANSP staff in 2016 but constituted 49% of ANSP staff costs, and 32% of total ATM/CNS costs. So ATCO unit employment cost, ATCO productivity and support (non-ATCO) unit cost are important factors in explaining overall cost efficiency. This is reflected in the annual analysis in the ACE report and measured on a gate-to-gate basis.

ATCO employment cost

The chart below shows ATCO (in operations) employment cost per ATCO hour in operations for the five largest ANSPs. This metric represents the average employment cost per hour on duty. It can be seen that our figure is in the middle of the range during the period shown, and has fallen since 2015. For four of the five ANSPs (the exception being DSNA) the cost per ATCO hour has usually been higher than the pan-European system average.

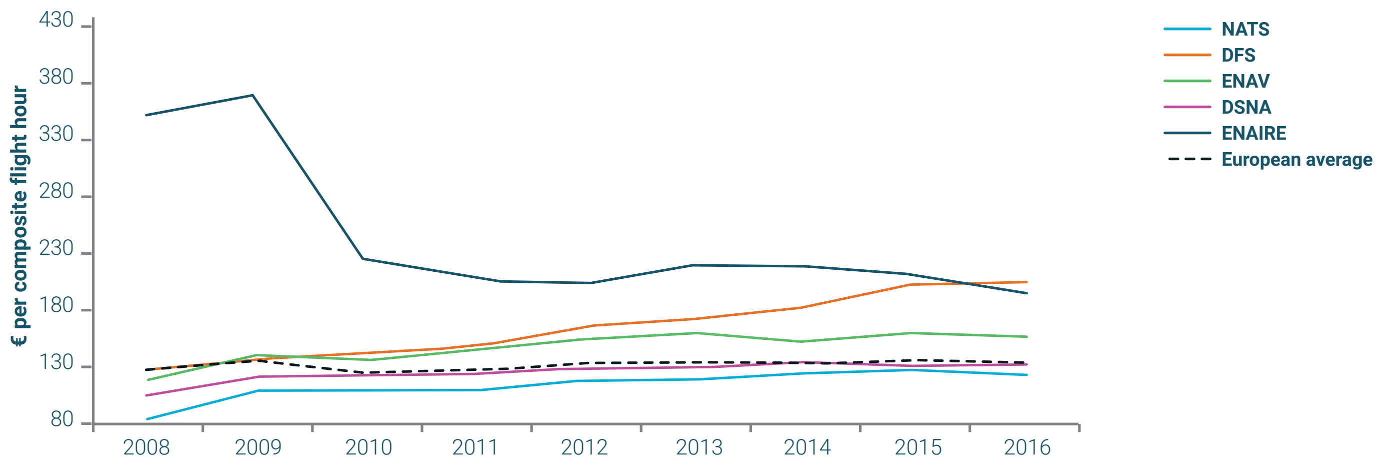
ATCOs in ops employment cost (€) per ATCO hour in ops 2008 - 2016 (gate-to-gate)



While ATCO employment costs per ATCO hour generally rose between 2008 and 2016 (the exception being ENAIRE of Spain), we maintained our position in the middle of the big five over the last few years, with a notable decrease in per hour costs from 2015 to 2016. We also continued to perform well relative to the simple average of the big five, consistently out-performing the average over the period 2008 to 2016.

The chart below shows ATCO (in operations) employment cost per composite flight hour. We have consistently been the best of the five largest ANSPs for this indicator, with unit cost below the European average.

ATCOs in ops employment cost (€) per composite flight hour 2008 - 2016 (gate-to-gate)



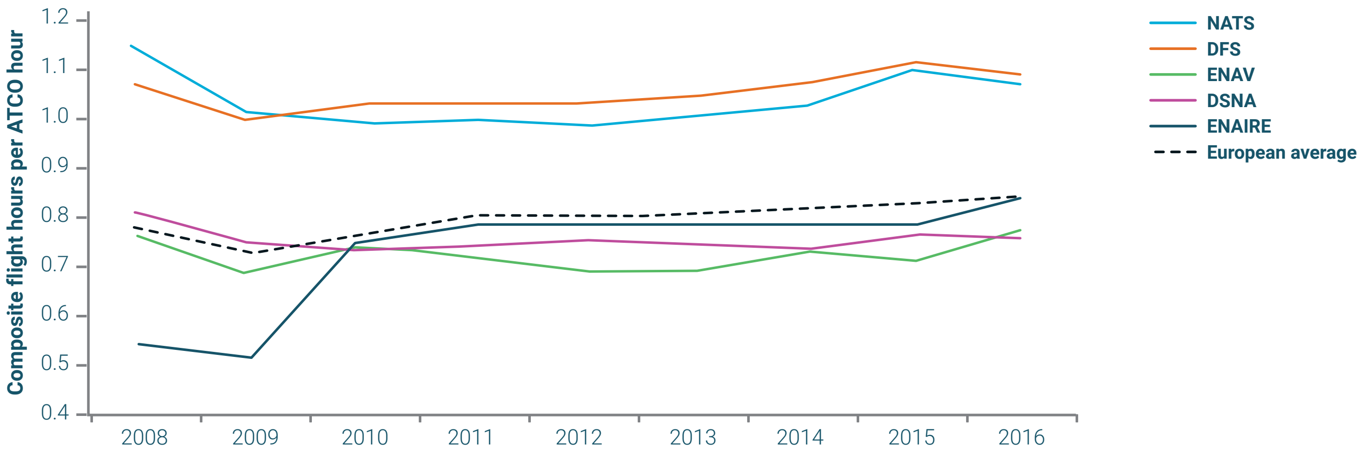
ATCO productivity

Relative productivity is also a key consideration for us. An ANSP may have (relatively) high ATCO employment costs per ATCO-hour, but if its ATCOs are efficient then it will tend to have lower employment costs per composite flight-hour. We perform relatively well on both measures, falling below the (simple) average in both cases. In terms of productivity, according to the ACE data, we are operating at the productivity frontier, relative to the other main European ANSPs.

In the chart below a comparison is shown between ANSPs' output in terms of composite flight hours and input from ATCO hours in operations. NATS and DFS have shown consistently high values for this indicator of ATCO productivity. While our ATCO productivity eased a little during RP1, it was consistently better than the pan-European system average and has been trending up since the latter part of RP2. In 2016, the most recent year for which published data is available, our ATCO productivity was the second highest of the five largest ANSPs and fifth highest overall; our figure of 1.07 compares favourably with the pan-European system average of 0.84.

It is important to note that the assessment of productivity used in the ACE data reflects the average productivity over a year for a given ANSP and does not give an indication of the productivity at peak times, which can be substantially higher. We also operate in extremely complex air space (see below).

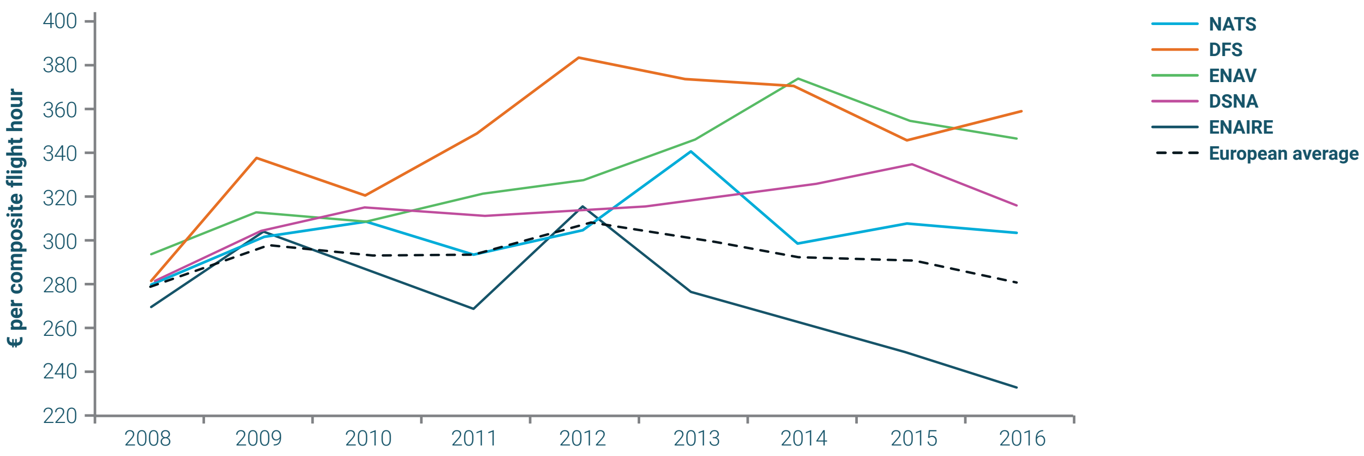
Composite flight hours per ATCO hour in ops 2008 - 2016 (gate-to-gate)



Support costs

In the ACE analysis, the PRC classifies all costs that are not ATCO related as support costs. The chart below shows support costs per composite flight-hour. Our support unit cost has tended to be lower than most of the other large ANSPs.

Gate-to-gate support cost (€) per composite flight hour 2008 - 2016



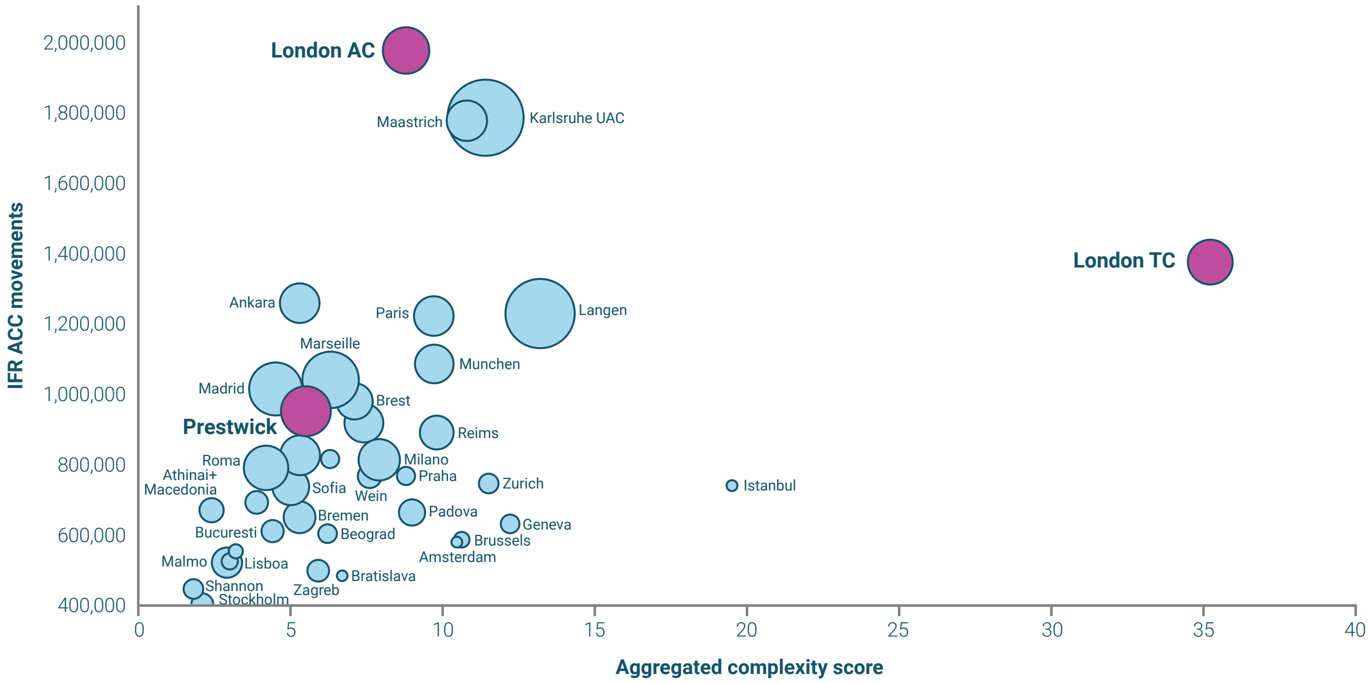
Complexity

In the PRC's annual analysis of airspace complexity, we have consistently had the highest level of complexity of the big five. In 2016, our score was 12.38 (in 2015 it was 11.74), compared with other big five scores ranging from 4.79 (ENAIRE) to 10.84 (DFS). Our complexity score is second only to Skyguide (12.70). The average complexity score was 6.92.

The chart below shows the traffic complexity of each European area control centre (ACC), as assessed by Eurocontrol, together with the traffic volumes they service and the number of sectors. London AC services the highest number of instrument flight rules (IFR) movements of any ACC in Europe, with fewer sectors, and therefore staff, of other large ACCs. London TC is the fourth largest ACC by IFR movement and is significantly more complex than any other EU ACC. For example, London TC's traffic complexity score was 35.2 in 2016, compared with Istanbul ACC's 19.5 in second place. It is important to take these factors in account when benchmarking, as they will have an impact on the cost effectiveness and productivity metrics.

ACC in Europe – IFR flights/complexity/no of sectors

Source: ACE Benchmark report 2016



Supplementary information

Unit rates v unit cost

	Unit rates	Unit cost (ACE)
Service	En route only (comparing terminal unit rates between states/ANSPs is difficult).	Gate-to-gate – to avoid cost allocation issues between en route and terminal, although high level unit cost figures are available for these two types of service.
Entity	State level only for pre-2012; ANSP unit rates available since 2012 for states participating in EC performance scheme.	ANSP level and (since 2012) FAB level.
Cost categories	State level unit rates for pre-2012 include costs outside ANSP control e.g. airspace planning; for post-2012, even with ANSP unit rates available, differences remain regarding which entity bears certain costs e.g. safety regulation, Met costs.	ANSP en route and airport ATM/CNS costs. Some costs that are included in unit rates (e.g. regulation, external Met costs) are excluded from the ACE analysis.
Accounting basis	UK unit rate reflects cash pension costs and regulatory depreciation.	Costs on IFRS basis as per statutory accounts.

Appendix K: Resourcing and resilience

This appendix describes the various types of resources required to deliver our plan outcomes with the level of operational and technical resilience needed. In the case of operational resources, we also describe how we plan, recruit and train air traffic control officers (ATCO), the level of productivity of these resources and the impact on plan outcomes if we fail to have the right numbers.

This element of the plan is important in providing a safe and resilient 24/7 service capable of handling the rise in traffic, while simultaneously changing our operation to create more capacity and capability for the future. The outcomes and resources that we plan are inseparable, not least given that we operate within a safety critical and heavily regulated environment. We have much less freedom to reorganise resources than in many other regulated sectors. Any material changes, therefore, to the numbers and mix of staff grades would cause us to have to reconsider plan outcomes and the delivery risks.

Operational resourcing and resilience

The level of safety, service performance and operational resilience that we provide is of great importance to airspace users. These priorities were reflected in our annual customer survey and throughout the RP3 customer consultation. The need to ensure operational resilience was reinforced by the CAA in their guidance on the development of our plan for RP3 and in a recent modification of our Licence (Condition 2) requiring us to provide a plan that provides resilience, contingency and business continuity. This must set out the principles, policies and processes through which we will comply with our obligation to develop and maintain the assets, personnel and systems required to provide the core and specified services.

Our operational resourcing was the focus of an investigation by the CAA relating to a formal complaint under the provisions of the Transport Act 2000 in 2016 - Project Oberon. Although the complaint was not upheld, we have acted on the recommendations contained within the Project Oberon report and continue to improve the way in which we plan and execute our services in order to provide a resilient service.

An important part of delivering the required service resilience is to ensure that we have sound strategic and tactical operational planning processes capable of delivering sufficient numbers of appropriately skilled staff in our operation. These points are considered in more detail below.

Strategic and tactical operational planning

The rate of traffic growth during RP2 has resulted in a number of sectors reaching capacity saturation. These sectors are particularly sensitive to further increases in traffic growth. So, in order to manage the forecast traffic growth during the remainder of RP2 and into RP3, without the benefit of significant airspace change in the near term, we will continue to operate and evolve the following planning procedures.

Strategic planning – from a year in advance to day minus five

We will carry out a thorough planning process to meet the needs of our customers. By engaging with Airport Co-ordination Ltd, airports and airlines as much as possible, we will be able to build a view of airline schedules and how these impact on airspace capacity. This will inform our planning process, and that of our customers, and ensures smooth operations on the day.

Where necessary, we will respond to and manage demand, bearing in mind the need to ensure sectors of our airspace are not overloaded and operations remain safe.

Pre-tactical planning – day minus five to day minus one

We will produce an operational performance outlook and plan to assure the best possible customer service. It will include mitigating actions for any significant events that could affect our operations, such as adverse weather or known staffing limitations. We will liaise with airports and airport ATC the day before operations and agree a tactical plan for the day, which we will continually review and update.

Tactical planning – during operations

During operations our focus will be on balancing demand and capacity to ensure we deliver our service safely and efficiently. When there is an imbalance between demand and capacity due to higher than expected traffic levels in a particular sector, we will aim to ensure we manage the network as a whole to best effect, while seeking to balance the outcomes across airports and airlines as far as possible.

Operational air traffic controllers

We operate in a safety-critical environment. This means we need to deploy our staff in ways that manage ATCO fatigue and comply with regulations that regulate and limit ATCOs' hours. We also have a heavily unionised workforce and a number of national and local working practice agreements to comply with. While we have a constructive and co-operative relationship with our employees, these regulations and working practice agreements limit our flexibility in deploying staff.

Resilience in operational staffing relies on our ability to provide sufficient staff with the right sector validations to meet the operational requirement for ATCOs. Traffic growth is not equally distributed across the network - a number of sectors see double digit traffic growth at peak times - and some sectors are already operating at capacity. So the relationship between traffic and delay is not linear.

Maintaining our good service performance, while ensuring we continue to deliver safety, environmental performance and operational resilience, is becoming increasingly difficult as traffic levels continue to break new records year-on-year. As a result, if there are insufficient ATCOs available to service the operational demand, there is a risk that even small levels of traffic growth may result in exponential delay. Although, it should be noted that as sectors reach full capacity, we may need to open additional sectors with their full complement of controllers.

In addition, the way that traffic presents itself on a daily basis is driven by a large range of factors, including weather, capacity, European regulations, airspace complexity, and air traffic strikes in Europe. However, we will always have safety as our priority, and, should the two outcomes conflict, will prioritise safety over service performance.

Before RP2, we reduced ATCO numbers to reflect the traffic levels forecast at that time and to respond to our customers' priority that we reduce the cost of our service. We reflected this in our RP2 business plan. However, our experience of RP2 has been that actual traffic has been significantly above the RP2 forecast. Industry feedback has demonstrated that there is sensitivity to delay at London airports, even when we are operating well within the RP2 performance targets across the network as a whole.

We have also seen that having too few ATCOs can have a disproportionate impact on service resilience, as well as on our ability to implement changes to our service while minimising disruption to customers. This is partly because our ATCOs work in small teams within a watch based structure, each ATCO having skills for a small number of airspace sectors. As a result, a reduction in the number of ATCOs or their skills can have a significant adverse impact on the deployable resource for a particular part of the airspace network. Our ATCOs are also required to support non-operational duties, which are critical to ensuring we can continue to deliver the required service in future reference periods. They include supporting the development of the technology and airspace programmes, safety, procedures and compliance with competency and training requirements.

The combination of these factors, and the fact that the number of ATCOs retiring or leaving the business has exceeded our expectations (for example through changes in pension tax legislation), means that we currently have around 30 fewer ATCOs than we need to deliver a high quality service with the right levels of resilience. Between now and the start of RP3, we expect the numbers of retirements and other losses to exceed the rate at which we can train new ATCOs, increasing this shortfall to around 50 ATCOs. Lead times of three years on average to recruit and train new ATCOs, and up to a further two years to achieve the level of sector validations of experienced controllers leaving the business, have made it challenging to meet the operational requirement. We have managed this, and will continue to do so, through increased productivity and overtime, and through improvements to our training and selection processes. However, this is not a sustainable position, and we need to ensure we can provide the required level of operational resilience with even higher forecast traffic levels.

Operational demand planning

We have an established process to forecast the number of ATCOs that we require for a safe operational service of the right quality and resilience, for example, to cover staff sickness, technical issues, weather, and industrial action in other countries. It considers strategic, mid-term and tactical timeframes, refining our understanding of the variables as time progresses.

This process considers the number of airspace sectors that we expect to open and for how long, the staff required to operate those sectors and the service quality needed. The traffic forecast is only one variable in the planning process, and is not the sole driver of ATCO headcount requirements. As explained below, many other factors need to be taken into account as well. Our operational teams use their expertise to model and decide how many airspace sectors we will need to open in the future, and therefore how many staff we will need. Based on this information, we forecast that in 2024 we will need 57 more ATCOs than in 2019 to provide the operational service.

We must also address uncertainty inherent in long term traffic forecasts. For example, airlines will respond quickly to changing passenger demand for different destinations by adding and/or changing their routes season by season. For example, some traffic has shifted from Spanish destinations in 2017 to Greek, Italian and Turkish destinations in 2018. This has increased the workload of airspace sectors covering the eastern part of the UK (see chart below). The dynamic nature of this process means that airlines often do not know which destinations or routes that they will use for the next season, let alone at the end of RP3. Therefore, we need to be in a position where we are able to plan for the long term in a way that allows us to respond to such changes in our customers' needs.

Changing short term traffic patterns, 2017 v 2018

An unusual factor in our business is the impact of the jet stream. Our unique position as the gateway to Europe from the North Atlantic means that changes in the jet stream have a significant impact on the way air traffic uses UK airspace, and so on the number of staff and skills that we require. If the jet stream is in higher latitudes, the air traffic travelling east tends to follow the jet stream and this results in heavy loads in many of our sectors in both Scottish and English airspace. If the jet stream is in a more southerly location then much of the traffic either enters the airspace of our southern sectors or sectors controlled by neighbouring ANSPs. The position of the jet stream is a significant determinant of our staffing requirement, but is not predictable more than four days in advance. We need to plan operations for both scenarios.

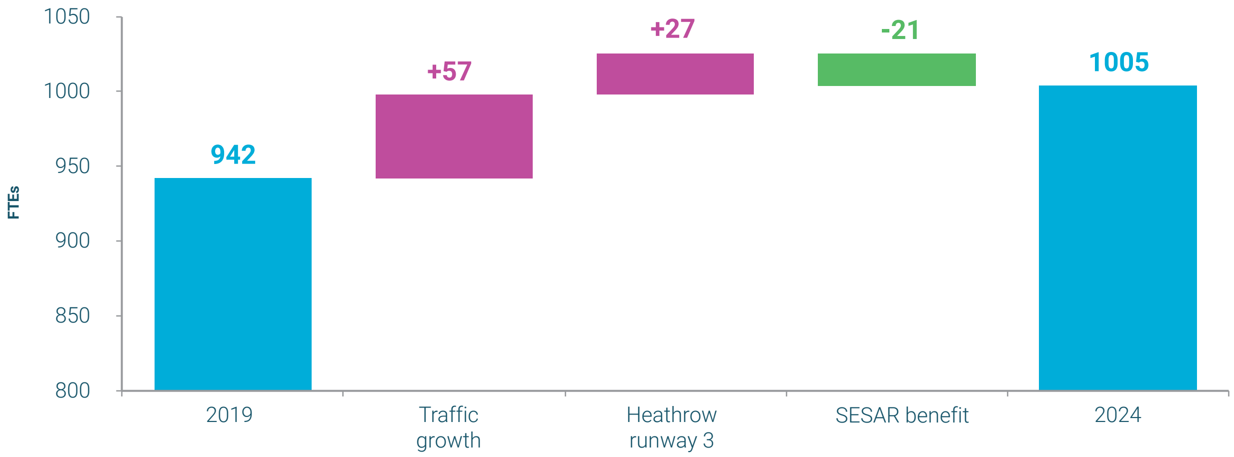
In addition to the increased staffing requirement generated by increased traffic, plans for a third runway at Heathrow in early RP4 further increase the ATCO requirement. The main impact will be on our Heathrow approach operation, but the additional traffic that a third runway is expected to generate will also increase the staffing requirement on the terminal control (TC) terminal manoeuvring area (TMA) operation as well as the high level sectors.

In total, we estimate the impact of a third runway at Heathrow will increase our ATCO requirement by 27 full time equivalent (FTE). Because of the lead time involved in training new ATCOs, and the limited capacity for on the job training, it is imperative that the recruitment of the staff required for a new runway starts well before the planned operational date. As a result, we plan to start recruiting and training the new staff during RP3.

The need for additional ATCOs in RP3 to service the expected traffic growth and an additional runway at Heathrow will be partly mitigated by the efficiencies in staffing from the deployment of SESAR projects. This arises from consolidating the area control (AC) and TC operations in a single operations room and implementing the early stages of dynamic sectorisation.

A summary of the forecast change in our ATCO requirement in RP3 is shown in the chart below.

Operational ATCO demand, 2019 v 2024



Non-operational demand planning

Alongside the requirement for ATCOs to provide the core operational service, we also need to ensure that the service is sustainable over the medium term. We therefore need our ATCOs to undertake work that is necessary to maintain the operation, including tasks such as competency assessments, professional training and development, and the operational training of new ATCOs.

While we are working to minimise the ATCO involvement in project work to ensure that they are focused on the operation, we nevertheless require some input from ATCOs in the development of both technology and airspace projects. This ensures that we get high quality outcomes from these projects and a better transition into service. ATCOs also provide significant input in the development phases of projects. Examples include simulations of airspace changes and training to operate new equipment, procedures and airspace before these enter into operation. This work is defined and planned through our investment programme, and forms part of the overall requirement for the number of ATCOs we need to sustain the business over time.

Supply planning

Our headcount supply plan aims to match the supply of ATCOs to the demands placed on them in order to provide the operational service, sustain the operation and support the investment programme. Our plan is to make up the current shortfall in ATCO numbers and then further increase the number of ATCOs in order to provide the service performance and operational resilience required.

In doing so, we aim to strike a good balance between having too many ATCOs, which would lead to higher prices, and too few, which could cause high indirect costs to our customers through delay, as well as delaying the benefits that will be delivered by the airspace and technology programmes. By having a margin for resilience we will be able to balance these risks. This approach is supported by the least worst regrets analysis, described below.

Key points underlying our supply projections are as follows:

> Operational demand: Our estimate of the ATCO FTE required to provide the operational service;

> Rosterable supply: The ATCO FTE effort available to deliver the operational service. This includes a proportion of time (four shifts per month) from ATCOs who retain operational skills but whose main role is devoted to other tasks, for example, training or supporting airspace changes;

> ATCO retirement age of 55 (Swanwick) and 56 (Prestwick), based on experience in RP2 and the expected impact of changes in pension tax legislation;

> ATCO trainee validation time from arrival on unit of 21 months (Swanwick) and 14 months (Prestwick), based on historical experience. The Swanwick operation is more complex than the Prestwick operation, accounting for the difference in validation time assumptions;

> Trainee pass rate of 75% (Swanwick) and 100% (Prestwick), based on historical experience. The difference in pass rates is related to the relative complexity of the operations;

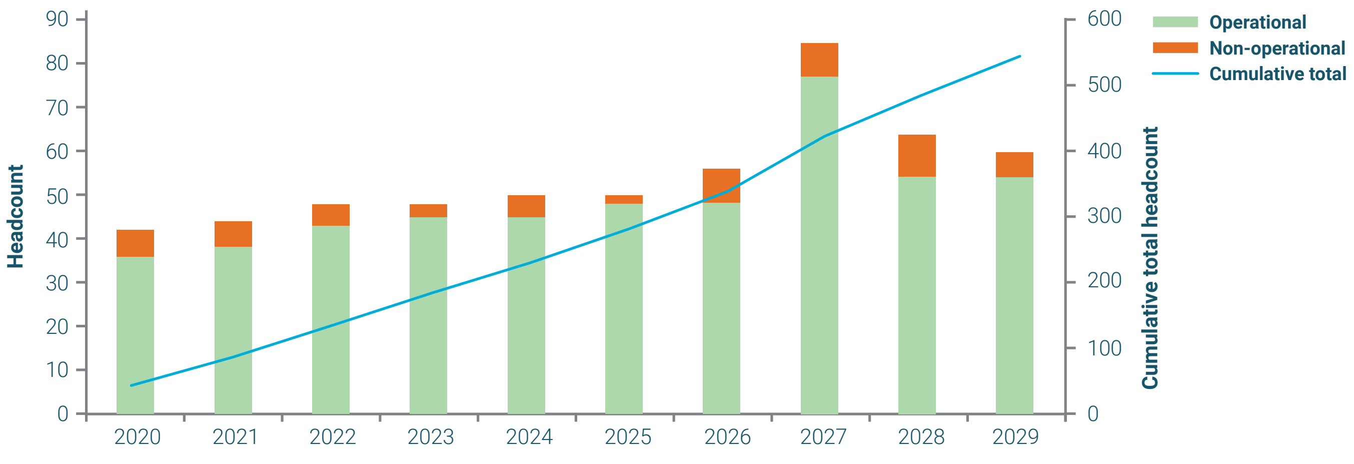
> Other ATCO headcount losses (due to, for example, medical reasons or resignations) are based on a five-year historical rolling average of actuals or similar historical experience; and

> Trainee air traffic controller (TATC) supply is based on the training college operating at full capacity.

Due to the demographic profile of our staff, we expect that many will retire during the next five to ten years. This will include more early retirements due in part to changes in pension tax legislation. ATCOs can retire with relatively short notice. This, combined with the long lead times to recruit and train, means that we need to manage the risk of staff shortages carefully. Further, the loss of more experienced staff with multiple validations leads to a reduction in flexibility in staff deployment until newly trained ATCOs acquire similar levels of validations. This can take up to two years following attainment of their first sector validation. This reduction in flexibility also drives the need for a higher ATCO headcount over the medium term.

The chart below shows our forecast of the increasing rate of ATCO retirement throughout RP3, peaking in 2027. In order to avoid the increase in retirement rates having an impact on our operational service, we need to increase the number of trainee ATCOs in RP3.

ATCO retirement profile



In Appendix J we noted that our ATCO productivity is high, despite the high levels of airspace complexity that we have compared with other ANSPs. In 2017 we handled the same level of traffic as in the previous peak of 2007, before the economic downturn. This traffic is now being handled with around 10% fewer ATCOs and 50% less delay, as shown in the graph below.

By 2019, we expect to have achieved improvements in efficiency through a number of means, including:

> Fully utilising available sector capacity: Increases in staffing are not directly correlated to increases in traffic. Staffing levels increase in a stepped profile. ATCOs (or a pair of ATCOs in some parts of the operation) tactically manage aircraft trajectories within a specific geographic airspace sector or group of sectors. As traffic grows, some of that growth can be maintained within the current open sectors and therefore by current staffing levels whose productivity increases. However, traffic will reach a tipping point where it becomes necessary to open additional airspace sectors, thereby increasing the staffing requirement. While this process will provide the required higher capacity, the productivity of the network will not be maintained at the same level until the full capacity of the new sectors has been utilised. The creation of more sectors provides the ability to handle even more traffic. However, this does not automatically translate into higher productivity because of the addition of the interfaces and the complexity introduced by each new sector;

> Investment in new technology: One of the benefits of introducing new technology is the ability to develop improved controller tools, thereby increasing the volume of traffic that each controller can efficiently and safely manage. Good examples of this are the aircraft trajectory projection and conflict detection tools (iFACTS) available to the area control operation;

> Investment in airspace: Airspace changes tend to increase the capacity of the airspace, primarily by reducing complexity. Again, this increases the volume of traffic that a controller can manage;

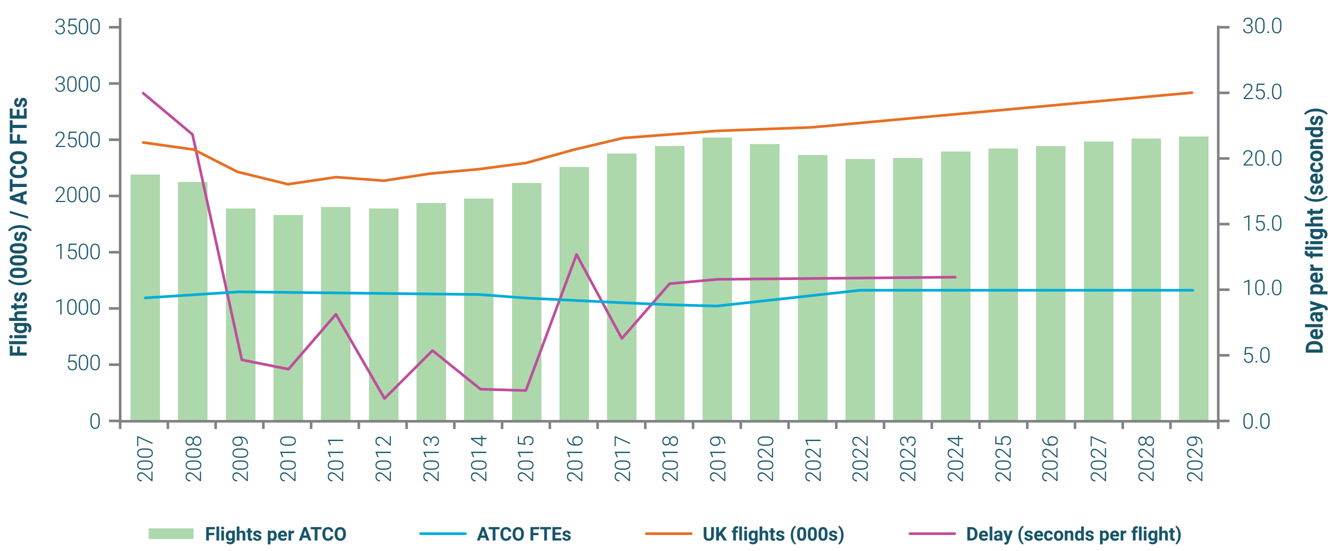
> Continuous improvement in the management of the operation: Innovation in the way the operation is planned and managed results in increasingly efficient use of staff to ensure that the right ATCO skills are available when required. For example, combining tactical and planner positions in low traffic periods; and

> Improved operational resourcing processes: Improvements in planning traffic and resource deployment allow improved matching of resource to traffic.

We expect productivity to peak in 2019. However, as explained above, this level will not be sustainable in the short term as rising traffic will generate the need for more staff along with even greater resilience. After 2019 we expect higher numbers of TATC validations which will increase our staffing and capacity levels to the appropriate operational requirement. As these ATCOs grow in experience (more sector validations) and additional sectors become fully utilised with projected traffic growth, then productivity levels will increase.

For RP4, we expect productivity to show continuous improvement as increasing traffic levels are managed by a similar number of ATCOs. This improvement will be enabled by the benefits from the new technology and method of operations, for example, dynamic sectorisation and tools based validation.

ATCO productivity



Given the factors described above, we plan to run our training college at full capacity now and into RP3. By the end of 2021, we expect that our ATCO headcount will exceed the operational requirement (demand) by a margin that allows us to:

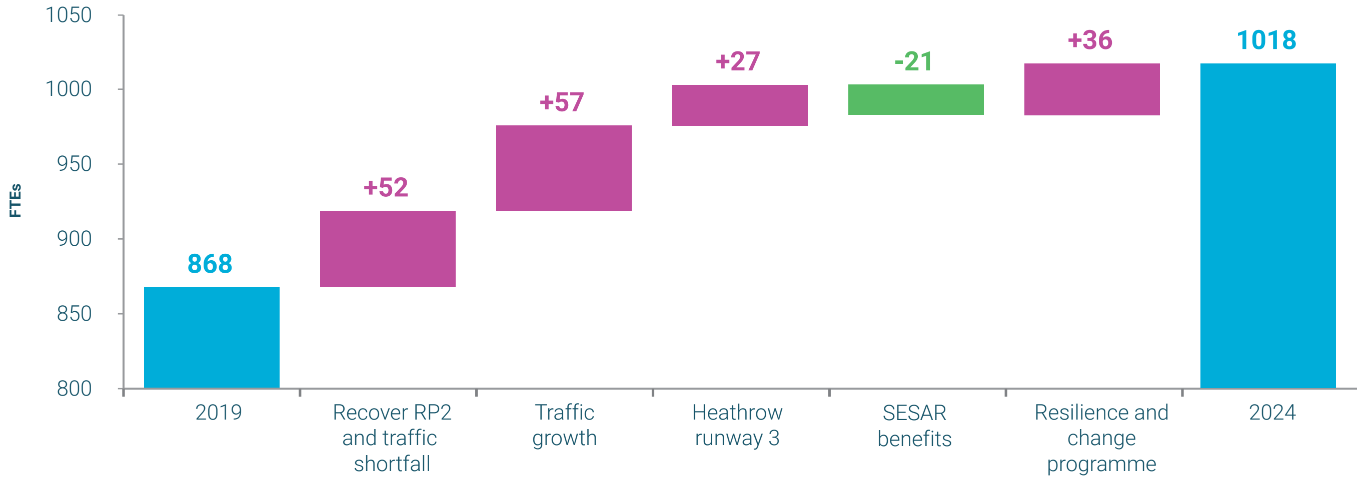
> Deliver increased operational resilience: This will reduce our reliance on employee goodwill and voluntary overtime to provide the service, and protect us against the risk of higher than expected early retirements. Voluntary overtime will be used largely to support airspace and technology transitions. We believe this approach strikes a good balance between resilience and efficiency;

> Provide a good level of service: With more flexibility to deploy staff to sectors that become busy through higher or different patterns of traffic demand, and without the benefit of airspace modernisation until the latter part of the reference period; and

> Support delivery of the airspace and technology programmes: This will need to progress alongside the delivery of the day-to-day service.

Turning to the factors leading to the increase in ATCO supply, these are summarised in the chart below:

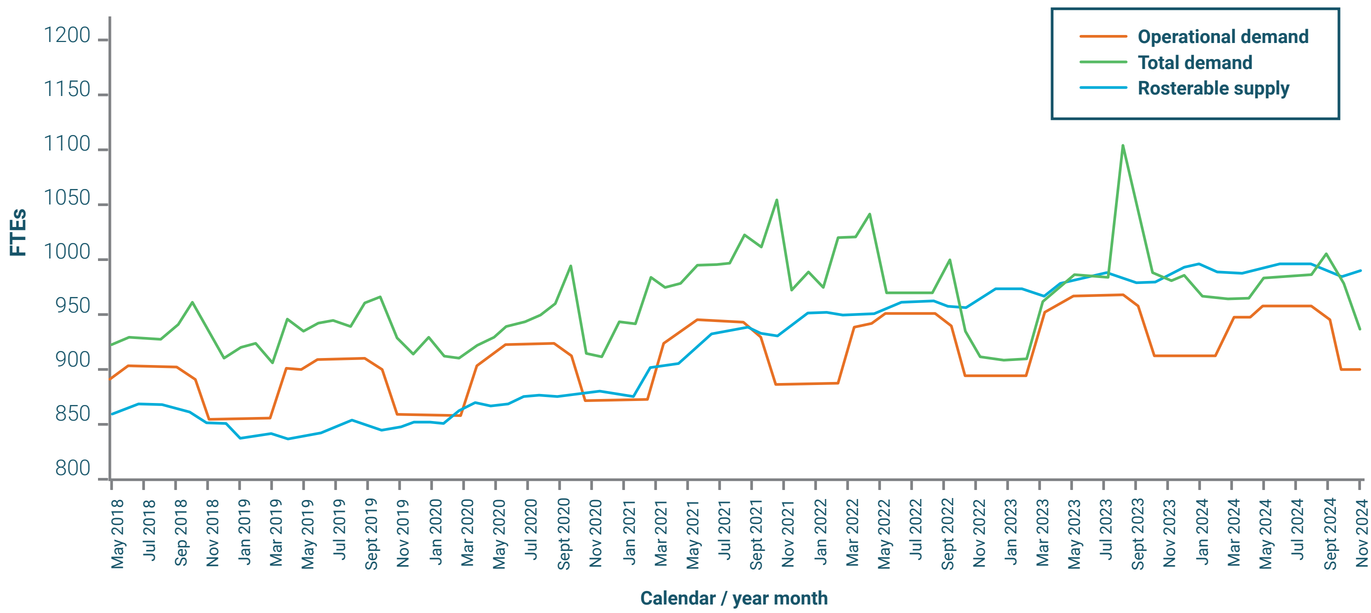
Operational ATCO FTE bridge, 2019 v 2024



Balancing demand and supply

The chart below shows the operational, non-operational and project requirement for ATCOs for the remainder of RP2 and RP3 along with our projections of total rosterable ATCO FTEs.

Demand v supply (total rosterable ATCO FTEs)



This chart shows how we plan to increase ATCO staffing to address the current shortfall and then to meet operational demand with appropriate levels of resilience. The development of our investment programme will place additional demands on ATCOs which we will meet through voluntary overtime and by ensuring that technology and airspace transitions are planned to limit the impact on the operation and service performance.

Other staffing options considered

Our planned levels of ATCOs will deliver our service performance targets and our technology and airspace change programmes. The service performance of our plan, along with the service performance of other options which we considered, but discarded, is as follows:

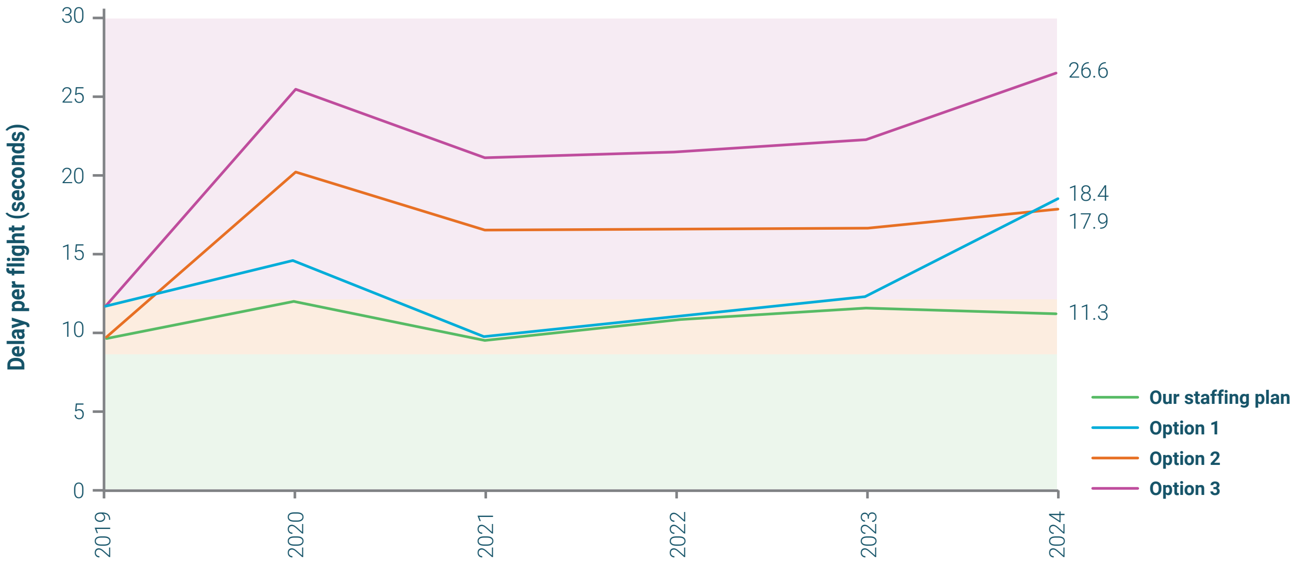
> Our staffing plan: Resulting in around 11 seconds of C2 delay at the end of RP3 which our customers have confirmed would be an acceptable level of service performance given increases in traffic that have occurred and that are projected in RP3;

> Option 1: Reducing the scope of our plan to exclude our proposed airspace change programme, resulting in around 18 seconds of C2 delay at the end of RP3;

> Option 2: Reducing staffing by 50 ATCOs, resulting in just under 18 seconds of C2 delay at the end of RP3; and

> Option 3: Reducing both scope of our plan and staffing (options 1 + 2), resulting in just under 27 seconds of C2 delay at the end of RP3.

RP3 C2 delay forecast



We have rejected the options shown because they would not deliver the service performance acceptable to our customers in RP3 and would adversely impact our ability to deliver the service performance that our customers are likely to require in RP4.

Further, we would expect the options which reduce ATCO resource (2 and 3 above) to lead to:

> Much greater volatility of delay performance, with increased likelihood of cancellations or first rotation delay;

> Our inability to implement airspace change and technology introduction - both are needed to modernise ATM and increase capacity to handle traffic growth; and

> Our inability to train new controllers to cope with traffic today as there would be no capacity to release instructors for delivery of training.

We have also considered whether we could further increase the numbers of ATCOs in our operation to provide even better service performance and resilience. However, given that our training pipeline is operating at maximum capacity, we see little opportunity to do this.

Trainee air traffic controllers

There is a high demand for ATCO resource worldwide and significant competition for high quality ATCOs, TATCs and training capacity.

Our plan is to recruit TATCs at the full capacity of our training college, supplementing this by the use of third party training providers where it is sensible to do so. This will enable us to build operational resilience more quickly and to respond faster to changes in the operational environment.

The planned entry of TATCs into operational service is shown below.

Planned entry of TATCs into operational service

Business area	18/19	19/20	20/21	21/22	22/23	23/24	24/25	Total
Swanwick - area	27	84	53	27	27	27	37	**282**
Swanwick - approach	29	20	7	20	15	15	7	**113**
Prestwick	15	20	25	25	20	15	15	**135**
Total	**71**	**124**	**85**	**72**	**62**	**57**	**59**	**530**

Previous benchmarking has shown that the duration of our initial training is favourable when compared with other European ANSPs, many of whom continue to train all of their students on all of the ATC ratings. Recognising the importance of our training function for the remainder of RP2 and RP3, we are investing in improving the end-to-end training programme for trainee ATCOs, with the dual aims of reducing the time to complete training and increasing the success rate. We have made significant reductions in the time required to achieve necessary ratings over the past few years.

Due to the variation in size, complexity and other operational commitments, such as airspace or technical system changes, it can be difficult to compare the unit elements of ATCO training. We consider ATCO training to be a single, end-to-end process, which we aim to improve continuously through our governing bodies. The imperative that we boost operational ATCO numbers to meet current and higher future demand has also driven our search for more innovative approaches to training. This has been aided by new technology and training techniques that have been developed and become available relatively recently, including:

> Learning needs analysis: A learning needs analysis (LNA) process provides a more holistic view of the learning requirement than our current training needs analysis (TNA) process. Whereas a TNA focuses on the tasks that need to be trained through a comparison of the current and future states of working and identifies the training gap, the LNA process that we are adopting scopes information from a wide range of sources and helps define the optimum learning and assessment methodologies;

> Bite-size learning: Breaking the training into smaller pieces and using varied media and styles to keep it engaging. There is a general trend for attention spans to shorten with the pressures of modern life and availability of modern technology. We are responding to this and targeting learning bites as short as five minutes;

> Spaced learning: The bite-sized learning is then spread evenly through the training programme, so participants get regular exposure to the learning content, rather than whole days of non-simulation based learning once every 30 to 45 days. This reduces degradation of their knowledge and maintains familiarity with the learning topics more consistently;

> Blended learning: Blended learning is a technique where learning content is delivered in multiple forms rather than just traditional face-to-face briefing. The face-to-face time is reinforced with online e-learning that can be anything from short videos or quiz questions to scenario driven, problem solving activities. This weaves together different modes of delivery in order to maximise the participant’s understanding;

> Spiral curriculums: A spiral curriculum repeatedly presents topics of learning to participants, with each exposure to a topic more complex than the last or included within a larger task, which reinforces the previous learning;

> Mobile learning: Learning on mobile devices, such as tablets, means our learners can access content where and when it suits them, unlocking the potential workable hours and other opportunities, and supporting the bite-size and blended approaches. Furthermore, mobile devices enable reminders to encourage the learner to study frequently for short durations, in line with the spaced learning principle;

> Augmented reality (augmenting a real world environment with computer generated, perceptual information): The use of augmented reality is rapidly becoming established in learning and we are looking to exploit this in order to enable and enhance learning at operational positions, such as simulators. Augmented reality can bring content to life and put it into context; and

> Gamification: We are looking at how to exploit the mechanics of games to drive better learning, including exploration and consequences.

Alongside the improvements in initial training we are focusing on improving the way we plan and deliver project training for ATCOs. This is particularly important in RP3 given the number of significant transitions that are planned over that period.

Operational support

Operational air traffic services assistants

Air traffic services assistants (ATSA) provide direct support to the operation and play an important role in delivering our service performance. They follow a similar watch based shift pattern to the ATCOs to ensure support is available to the operation 24/7. Operational ATSAs provide:

> Direct support to ATCOs: This includes supporting the co-ordination of flights moving between different airspace sectors and into adjoining airspace that is controlled by other ANSPs. They also deal directly with aircraft and aircraft operators with non-standard flights and Class D clearances;

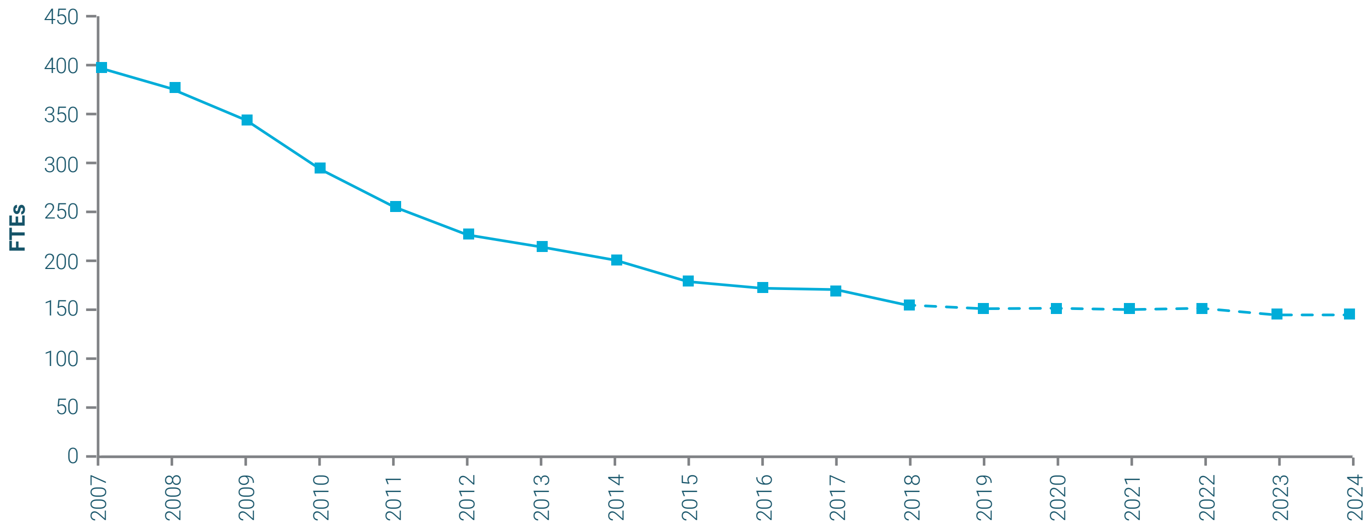
> Flight information service: This includes providing an air traffic service to flights operating outside of controlled airspace; and

> Flight plan correction: This includes providing a real-time correction service for flight plans that do not file correctly or need updating.

We have reduced the numbers of our operational ATSAs significantly over recent years, down from around 400 FTEs in 2007 to 168 in 2017 - around a 60% reduction. This has been achieved through consolidation of our operational centres, the introduction of new technology such as iFACTS, electronic flight data (EFD), and iTEC, and continuous efficiency improvements in the way we utilise staff.

Between 2017 and 2024, the number of operational ATSAs is planned to decrease by a further 23 FTEs, reflecting the reduction in demand through the introduction of electronic flight strips in Swanwick TC and the anticipated benefits of combining the AC and TC operations rooms. This reduction in headcount is shown in the graph below:

Operational ATSAs - actual/planned profile



Our RP3 plan relies on operational ATSAs continuing to play an important role in the delivery of the operational service. We considered options in the SESAR programme to remove the ATSA flight data operator role from the operation of our new systems. However, we did not adopt this option for the following reasons:

> Cost and programming constraints within the investment programme;

> The migration of this role to other grades of staff (including ATCOs) would require trade union negotiation and training at a time when the size of the change programme is already significant; and

> ATSA salaries are lower than ATCOs and therefore this would not be the most cost effective option.

In order to maintain resilience and cost efficiency in the supply of ATSAs, we are increasing the level of cross-skilling between operational and non-operational ATSAs, ensuring that there will always be sufficient ATSAs available to staff the operation.

Non-operational air traffic services assistants

Non-operational ATSAs:

> Support ATCO training and airspace simulations: Both activities will increase towards the end of RP2 as we increase training numbers and the simulations required for DP En Route. These non-operational ATSAs will reduce slightly in early RP3 as training and project activity reduces from peak levels. These resources are needed to maintain ATCO training and to avoid introducing risk to the timescales for the implementation of the technology and airspace programmes; and

> Provide other operational support: These tasks include working on airspace capacity management, ATC development, safety improvement and investigation and operational procedures. These resources will increase towards the end of RP2 due to the requirement for an increased network management capability resulting from traffic growth and the move to an increasingly systemised operational approach. They also support the airspace team on delivery of the change programme. After 2021, as airspace development requirements reduce, these resources also decrease. By using ATSAs in these roles, we avoid using more expensive ATCOs who are in short supply and needed elsewhere in the operation.

Any reductions in these critical resources would risk the quality of our operational service, our ATCO training plan and the delivery of our change programme, particularly airspace modernisation.

Non-operational air traffic controllers

There are a number of ATCOs who use the skills and experience gained as an air traffic controller in roles based outside of the operation. This includes roles required to ensure the on-going sustainability of the operation, such as ATCO training, safety investigation and improvement, and operational procedures. There are other non-operational ATCO roles that support the delivery of the investment programme, ensuring that systems and airspace designs of the future are of a high quality and capable of a smooth transition into service. Some of the non-operational ATCOs maintain an operational skill, typically providing an operational service for four shifts a month. This ensures continued alignment between the operational and non-operational tasks, and provides additional operational skills that can be flexibly deployed to support the service delivery.

Over the course of RP3 we plan to maintain the numbers of non-operational ATCOs stable at the current level of around 150. This is despite an increase in the demand for the non-operational tasks that they perform, for example from increased traffic increasing the complexity of procedures and safety investigations, an expanding airspace programme to support, an increase in the number of TATCs to train. This is to be achieved through continued efficiency, and through the migration of some of these tasks to other grades where tasks allow. The tasks that these staff undertake are key to the on-going sustainment of the operation. Therefore, a reduction in the number of these staff would result in a need to remove ATCOs from the operation and risk a reduction in the quality of the service.

Science, technical, analytical and research grades

Staff working in these roles provide key analytical and statistical skills to the operation largely in the areas of safety, service quality and environment:

> Safety: Providing analysis of safety data in order to identify opportunities to decrease risk and preserve the integrity of our safety strategy.

> Service performance: Providing analysis and insight to:
  - Improve strategic decision-making through accurate forecasting of future traffic demand;
  - Improve our service performance and the ways we can do this;
  - Identify the timing and impact of strategic investments such as enhanced airspace capacity;
  - Support business reporting and regulatory compliance;
  - Assess the benefits of investment projects; and
  - Support the operation in performance management.

> Environment: Providing analytical support for:
  - Airspace changes including the provision of metrics and analysis for airspace change proposals;
  - Simulation modelling to aid airspace design work and early design visualisations;
  - Environmental modelling and evaluation for current and future ATM operations primarily focused on aircraft fuel burn, CO_2; and
  - Understanding the ATM contribution to environmental performance.

The average numbers in these grades remain stable from RP2 into RP3 even though staff will be absorbing a higher workload.

Managerial support grades and personal contract grades

Our managerial support grades (MSG) and personal contract grades (PCG) provide necessary support and expertise in:

> ATCO training: In response to the significant increase in training demand and to enable increased focus on training improvement. This prevents the diversion of valuable ATCO resource from the operation and is a cost effective way of meeting additional training demand.

  – The impact of not having or reducing these resources would be a slowdown in the training pipeline and/or a reduction in service performance as ATCOs would be required to support the training instead.

> Operational resourcing: These staff provide significant benefits to the efficiency and effectiveness in deployment of operational resources. In addition to the work that is carried out on generating more efficient rosters, they provide insight into the operation through analysis and planning activities in support of the operational management.

  – Without this work, the deployment of operational staff would become less efficient and decision-making would become less reliable.

> Operations integration and planning: These resources are focused on improving the overall performance of the air navigation service system through standardising ways of working across the operation and helping to facilitate improvements in forward planning with collaboration from industry partners.

  – Without them, opportunities to improve the resilience and service quality of the operation may not be realised.

> Development of our change programmes: The scale of the airspace and technology change programmes facing the organisation is such that significant focus from the development teams is needed to ensure that the solutions that are developed are fit for purpose and are deployable into the operation.

  – Without this focus, there is a real risk that the change programme will not deliver benefits and that its operational implementation will be longer and more costly than planned. These resources also help to minimise the non-core burden on operational ATCO staff.

> Operational safety: Safety will remain the number one priority of the business and the performance in this area, in an increasingly complex and busy operating environment, relies on a continuous improvement ethos by seeking out areas of risk that can be managed, and anticipating incidents before they happen.

  – Without this team of dedicated individuals, the risk of safety performance not improving, or even worsening, is likely to increase.

> Other support requirements.

The average numbers in these grades increase from RP2 into RP3. This reflects the significantly higher workload, including tasks which staff in these grades will perform and that previously would have been undertaken by scarce and more expensive operational resources.

Analysis of trade-off between staff costs and costs of delay

Operational resilience is a key priority for RP3. Our ATCO headcount in RP3 must provide customers with the appropriate level of service in the context of increasing traffic forecasts, and deliver complex airspace and technology change programmes, while ensuring a robust level of operational resilience.

Balancing a highly skilled resource requirement in a context of uncertain demand, operational resilience and cost efficiency is challenging. There is a complex relationship between traffic volumes, staffing levels, our ability to service a large capital investment programme and the impact on delay. This is particularly the case in our environment where overall traffic increases can result in far higher increases in sectors that are already busy and where there are validation constraints on ATCOs for each sector. Tactically, on a short term basis, we can adjust resource capacity to a certain extent through overtime. However, there are limits on the additional capacity that can be created in this way[1].

Previous experience has shown that reducing operational resources can lead to a sub-optimal outcome for customers. For example, in order to meet the challenging cost efficiency targets in RP2, we reduced ATCO headcount to a level that would support the assumed traffic growth[2]. When traffic increased at a significantly higher than expected rate in early RP2, we were unable to increase ATCO supply at the same rate due to the lead times involved in recruiting and training staff. This, coupled with other factors, meant our capacity performance in 2016 was 12.7 seconds per flight (against a target of 10.8 seconds per flight), and we faced complaints from some customers where there were localised impacts on the operation[3].

[1] Increasing overtime schedules relies on voluntary agreement from staff and may depend on the employee relations environment.
[2] At the start of RP2, the CAA accepted our proposals - and forecast staffing levels - considering it to be "a reasonable and realistic profile of staffing over RP2".
[3] CAP 1578, Investigation under section 34 of the Transport Act 2000: Project Oberon, Final Report.

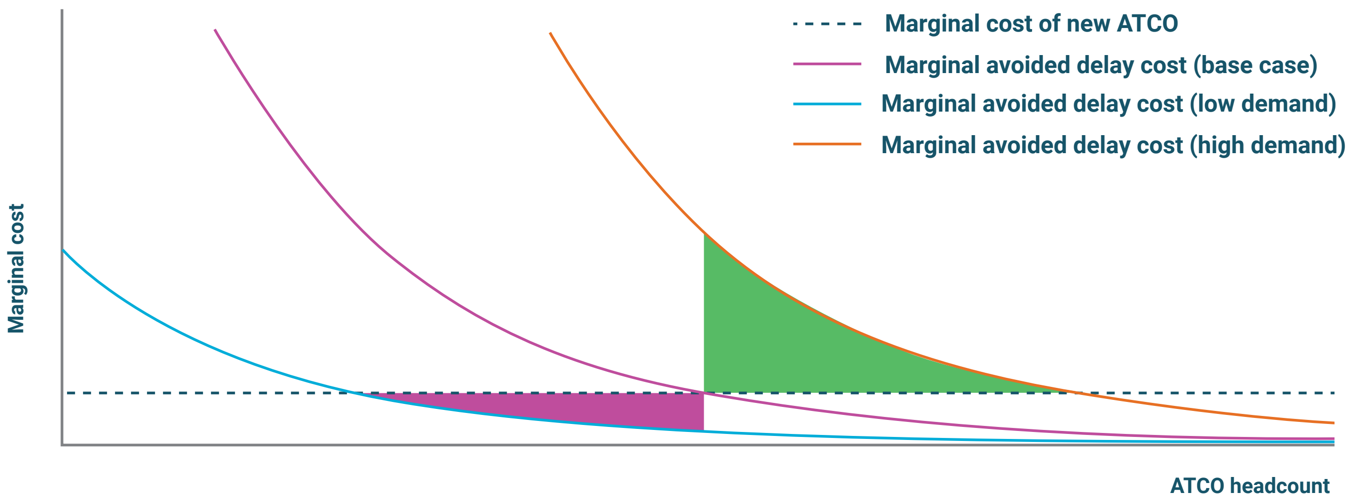
We recognise that the cost of delay, in terms of wasted fuel and the value of passengers' time, is large – recent estimates suggest that every second of air traffic flow and capacity management (ATFCM) measured as average delay per flight in the UK adds over £4m[4] to airline costs. This is a significant potential cost, and we recognise the importance of providing customers with a level of service that minimises delay. Therefore, our core plan contains an efficient level of staffing, consistent with an appropriate level of operational resilience and capacity performance requirements.

The principle of including an additional margin of operational staff, above the operational requirement, is supported by least worst regrets analysis. This approach has been adopted in a number of other sectors to ensure that regulated companies and regulators make decisions on behalf of consumers that maximise the cost benefit of operational resilience, staffing and efficiency.

Illustrative least worst regrets analysis results

The least worst regrets approach captures the trade-off between the staffing cost (training costs and salaries) of hiring additional ATCOs (which may be more than is required to meet a forecast demand, but which would be necessary should higher demand materialise), and the wider costs incurred by customers and others (in terms of delays) if we do not have sufficient ATCOs to meet demand.

Least worst regrets



The trade-off between incremental staffing costs and costs of delay is shown in the chart above. The dashed line shows the cost of a new ATCO hire, including training costs. The blue, purple and orange lines show the avoided delay costs from adding additional ATCOs to meet three demand scenarios (low, base case and high).

The intersections between the dashed line (cost of a new ATCO) and the lines corresponding to each of the demand scenarios (marginal avoided delay costs) indicate the optimum level of staffing for each demand scenario. At these points, one additional ATCO would not justify the savings in delay costs, while one fewer ATCO would add more in delay costs relative to direct cost (salary and amortised training costs).

However, the demand uncertainty also imposes asymmetric costs on our customers - the cost of understaffing (delay costs) significantly outweighs the cost of overstaffing (incremental staff costs). The purple shaded area represents the unnecessary ATCO costs over the reference period if we staffed for the base case demand, but actual demand was low. The green shaded area represents the delay costs if demand was higher than planned and we had staffed only to meet the base case demand.

In the event of lower demand than assumed, over the long term we could reduce resource, incurring the necessary redundancy costs. Alternatively, if we plan resources to meet demand at a lower level than actually materialises, this may result in lower initial staff costs, but the costs of delay are likely to be high.

Therefore, the optimal outcome is to include a margin of operational staff, above the operational requirement for the expected (base case) traffic forecast, ensuring resilience. This point is underlined by the time required to train ATCOs, up to three years for a single validation, and the tightness of the ATCO labour market in the UK and overseas which is relatively small and illiquid.

We have used this principle in our ATCO headcount projections in RP3, as described above.

[4] Based on University of Westminster delay cost of €91 per minute of delay (2009 prices). With 2.5m flights p.a., each second of average delay per flight in the UK equates to c.42,000 mins delay. At Euro exchange rate of £1 = €1.15, and updated for inflation, this equals c. £4.2m per second.

Technical resilience

Key to providing our day-to-day performance is the underlying resilience of the systems and services that support it. Following the independent enquiry into the system failure on 12 December 2014, the CAA consulted on a proposed set of resilience requirements for our operations that underpin our technical performance goals. We are fully supportive of these requirements and our objective is the continued provision of systems, procedures and resources that are capable of meeting them.

A further outcome from the independent enquiry is a requirement for us to produce a resilience plan, which will explain how we meet our obligations with regard to resilience, contingency and business continuity. This plan will be published in March 2019, in accordance with Condition 2 of our Licence. This section provides a summary of the key aspects of our approach to meeting this objective.

Technical service resourcing

Ensuring that we have the right technical resources is critical both to delivering our day-to-day service and the change programme that will position our service for the future. In Chapter 5, we described how we are transitioning to a new information technology infrastructure library (ITIL) service model, and the benefits of this. During the transition we will need to maintain key expertise on existing systems, as well as support a level of dual running as new systems are introduced.

Our headcount plan is based on this transition, underpinned by realistic assumptions for retirement and other drivers of staff turnover. While there will be challenges to retraining and recruiting to fulfil the new roles, success in realising the plan will also require a real focus on retaining key staff, and supplier support, to maintain and operate the existing systems during their final years of operation.

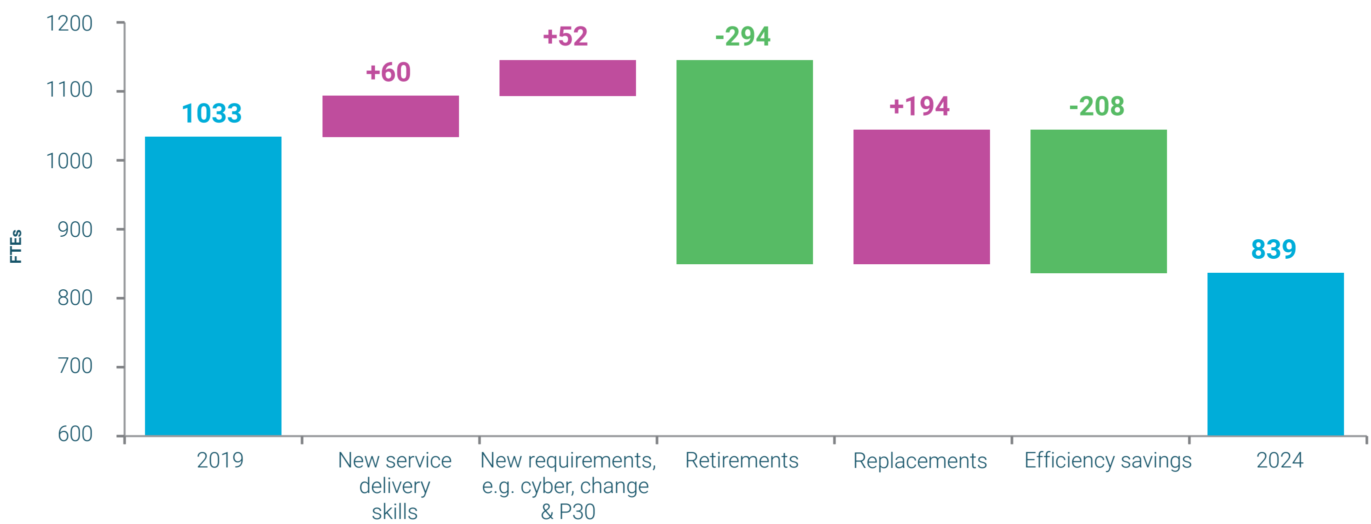
We are working with staff across the business to plan effectively for these changes to ensure that we are in a position to fully operate and maintain all of our services through these transitions.

Between 2018 and 2024 we will be reducing our technical services headcount by around 22%. This is not the full extent of the real reduction given that we will also be delivering increased scope, for example within cyber security, and to support ExCDS (a major new electronic system replacing a paper system) as well as new second systems for additional resilience which do not currently exist. We are also planning to deliver around 60% more simulator hours in 2019 compared to 2018 and virtually double the TATC input in the same period.

We estimate that the complexity of our service operations will increase by around 20% in 2019 compared to 2018. iTEC and FourSight are key examples of systems we will be operating in the future that are hugely more complex than those we currently use. We retain a combination of permanent and contractor resource to enable us to respond flexibility to meet these requirements.

The factors leading to the decrease in technical services FTEs are summarised in the chart below:

Technical services FTE bridge, 2019 v 2024



The movements in headcount are explained as follows:

- Recruitment of a wider pool of technically qualified staff with industry standard ITIL service delivery skills reflecting best industry practice and trained and skilled to operate in the new SESAR environment;
- Addition of staff to deliver the requirements of our technology change programme including cyber security, dual running of both legacy and SESAR environments and enhanced P3O capabilities such as requirements management and change management;
- Our estimate of retirements during RP3 with fewer replacements reflecting reduction in the level of activity on the investment programme; and
- Savings in headcount driven by the evolution to our service orientation approach, enhanced modern tools and capabilities, and systems to automate manually intensive processes.

Maintaining the right balance of resources to meet our operational needs throughout the period ensures that we are able to:

- Deliver our day-to-day operation;
- Support the deployment programmes required to evolve our service;
- Support dual running of our new and old systems during the transition period;
- Support new capabilities and systems introduced by our transformation programme; and
- Progressively reduce headcount as our transformation programme is completed.

Our plan sets out the necessary resources to achieve these objectives while also ensuring the resilience of our systems as described below.

Systems resilience

Our ability to provide and maintain an acceptable level of service is the cornerstone of our technical capability. The technologies and processes we have in place are resilient, and our recovery plans are effective if required. As we transition to the new SESAR architecture we need to evolve our technical resilience plans to support these new platforms as well as new requirements such as cyber security.

At the heart of our overall approach to resilience are the twin tracks of prevention and timely recovery should a failure occur. Our aim is to ensure that we maintain and operate an infrastructure of systems, people and processes that minimise the likelihood of overall service failure, the impact of failure and the time before recovery to normal operations can be achieved.

Key elements of our plan to support these outcomes include:

- Adequate skills and resources to maintain and operate current systems and support the transition to future systems, introducing a new operating model, aligned with ITIL, reflecting best industry practice;
- Ensuring our engineers' knowledge base of the new technologies is sufficient as we introduce new systems into the service;
- Investment in current systems to maintain and sustain them, using a risk based approach, until their end of life;
- Continuing to enhance our cyber defences as threats evolve and enhance subsequent recovery processes;
- Delivering a modern resilient architecture through DSESAR, including a flexible modern platform, comprehensive levels of redundancy and the availability of second systems as a final layer of protection; and
- New tools and technologies supporting systems operations to improve both efficiency and effectiveness.

This is underpinned by the approach described in more detail below, depending on whether systems and services are in operation or under development.

Systems and services in operation

Our existing systems and services have provided high levels of resilience and performance, delivered through the combination of key factors that include system designs and maintenance and operating procedures. Underpinning this performance is the existing resilient architecture, which includes the use of redundancy in system designs and overlapping cover for communications and surveillance services.

Building on these core capabilities, we will maintain resilience through use of sound risk management and operating procedures, including:

> A comprehensive approach to asset management, based on regular health reviews, preventative maintenance and planned investment to maintain operational performance;

> Protection against specific risks and threats, both physical and cyber;

> Robust procedures for managing and operating systems during normal and abnormal circumstances, including event management and fall-back procedures;

> The scheduling and management of planned change activities to minimise the risk of a change causing a service impact; and

> An open reporting culture that captures events that did not go to plan, even if they did not result in any operational impact so that we can continuously improve.

Systems and services in development

Deploying SESAR provides the opportunity to make further improvements to resilience, with a standardised, highly resilient architecture defined in advance as a framework for all new developments. This framework has been defined with clear performance requirements, including those for resilience, fall-back and recovery linked to the requirements defined by CAA.

To ensure resilience in the solutions we implement, we take a clear, well defined approach to development, including:

> Robust architectural reviews to ensure solutions are fit for purpose and able to meet performance requirements, adopting best industry practice and manufacturer guidelines;

> Use of standard and commercial off the shelf solutions where possible, with a well defined approach to validation and assurance also allowing effective patching to maintain up to date software and ease of support;

> Robust and planned approaches to transition to minimise risk and impact during change, building on lessons learnt and closer customer engagement;

> Deployment of a world class security operation centre to monitor our infrastructure in real time, ensuring we are effectively protected from the evolving cyber threats; and

> Provision of industry-leading tools and processes to support predictive analysis, preventing service degradation.

Managing evolution of our systems

Deploying SESAR will deliver a total transformation to our technical systems and the way we provide many of our operational services. It is essential that we put in place the right resources to ensure that we can maintain technical resilience before, during and after this transformation process.

The primary period of transition will begin in 2019 when we start to operate an early version of the overall DSESAR platform to support testing, validation and training. This process will start a period of dual running during which the new systems will be operated in parallel with our existing systems, requiring additional staff and licence costs in addition to those required for normal operations. This period of dual running will operate from 2019 until 2022 when the final stage of transition to the new DSESAR platform is complete.

Following completion of the dual running we will start a new steady state operation based on the DSESAR solutions. There will be three key changes to the resource requirement necessary to ensure resilience in this new environment compared to 2018 – the last year before the dual running period and the introduction of new capabilities:

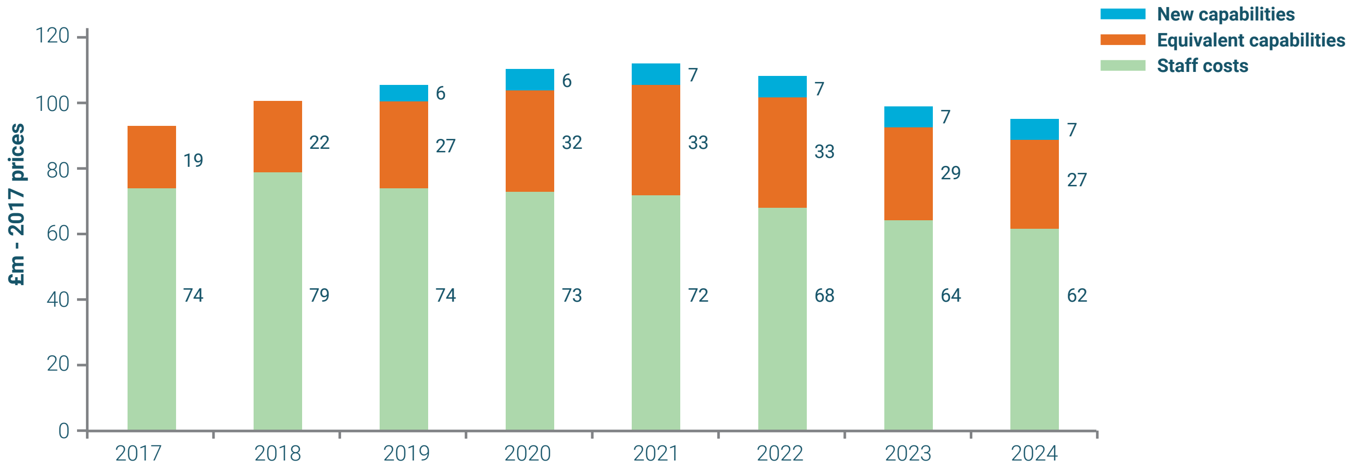
> Overall, technical services staff costs required to maintain and operate the systems will reduce by 22% from 2018 to 2024, reflecting a net reduction in cost of £17m;

> The opex costs associated with operating the equivalent capability will increase slightly as the new capabilities will require additional licence and support costs which were not typically applicable to our legacy systems; and

> A number of new capabilities will be introduced, specifically in relation to cyber security, resilience and electronic tools in TC, costing an additional £7m p.a. to support.

These variations are summarised in the chart below.

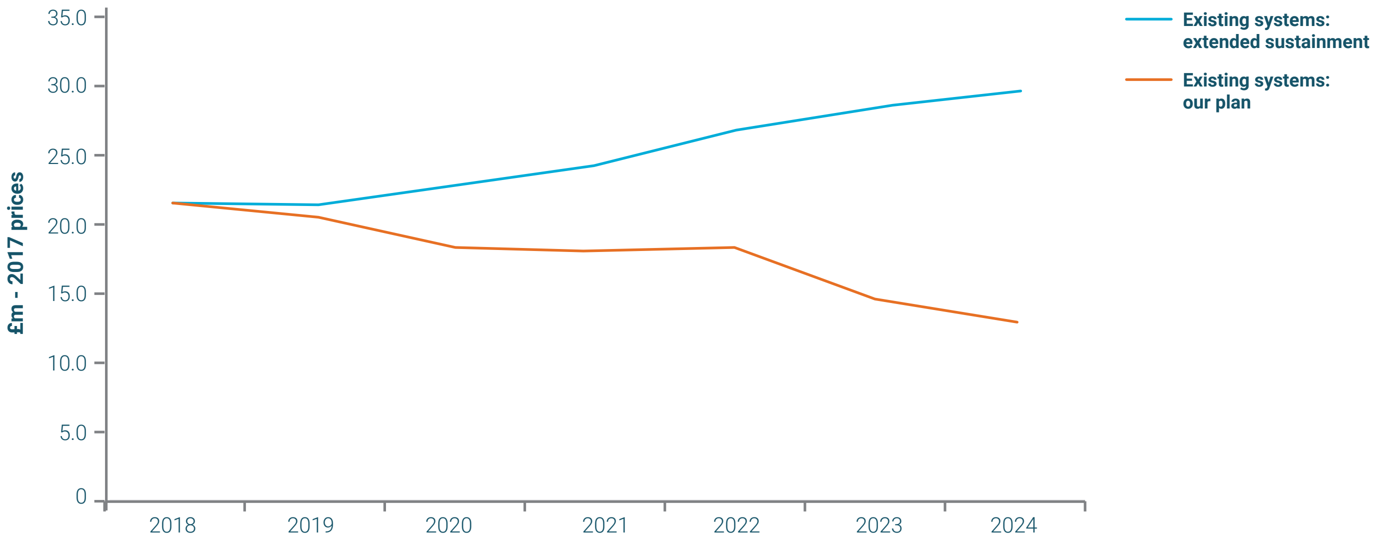
Costs associated with operating our systems



The most complex elements of this chart are the costs for the equivalent capabilities. The way these equivalent capabilities are provided will evolve over time. New systems will be introduced and old ones retired to deliver the same core capabilities, and the chart illustrates the evolution in operating costs over time. These costs will increase as we enter dual running of new and old systems, and then will show a reduction as the old systems are removed. The final total for operating costs for these equivalent capabilities will be higher than the 2018 costs, which represent the cost of operation of our current systems. This increase reflects the additional licence costs associated with these new systems compared to our existing systems for which such licence costs will no longer be required.

However, it is also worth noting that these operating costs are still less than the cost of trying to maintain and sustain our existing systems beyond their end of life dates. This anticipated increase in operating costs, if it were possible to maintain the existing systems, is illustrated in the chart on the next page.

Escalation of costs for legacy systems in RP3



As shown here, the operating costs of our existing systems would increase significantly if we tried to sustain them through RP3, assuming that this were possible, rising to a cost of around £30m p.a. This would be higher than the final costs in RP3 for the evolved systems (around £27m p.a.) and also would not enable the reductions in staff costs planned for this period.

Overall, the planned resourcing for RP3:

> Ensures resilience of our service during transition to new systems;

> Enables reductions in staffing through the efficiency of new ways of operating;

> Introduces new capabilities, including enhanced cyber security and resilience; and

> Delivers this as a reduced like-for-like cost compared to our existing service, which is cheaper than trying to sustain the existing systems into the future.

Other support staff

Managerial support grades and personal contract grades

These resources are primarily our senior professionals, subject matter experts and support staff (MSGs and PCGs). The need for these resources is driven by external and internal business requirements, for example, a raised cyber threat, rather than being directly related to traffic volumes. These staff operate right across the business, and the profile of headcount reflects increasing requirements in areas like cyber security and resilience, alongside roles requiring a high level of specific expertise. Significant requirements in RP3 include:

> Support to the airspace modernisation programme, with increasing requirements around consultation and engagement, which will require a formal consultation on proposals that will affect around 26 to 27 million people;

> Employee communication resources for our technology and airspace change programmes as they enter phases that bring about change affecting the largest numbers of employees;

> Support for the increased TATC recruitment profile, as well as the redesign of the recruitment process and selection model, to increase TATC pass rates, saving cost and time. It will also support the redesign of terms and conditions to create more flexible working arrangements and employment offering in a highly unionised environment, and to manage an increasingly complex employee relations environment;

> Resources to meet growing regulatory and interoperability requirements, further complicated by Brexit, and the requirement to manage future safety risk with growing traffic;

- Investment in developing the capability of the leadership and management teams across the business to handle the scale of the airspace modernisation and technology changes, including the move to one operation;
- Resource to respond to anticipated new CAA/DfT noise control measures requiring impact assessments to manage noise from our existing operation and RP3 airspace developments for overflown communities, and improving 3Di performance to save fuel for airlines and achieve environmental targets;
- Resource to ensure that we can deliver all the required safety benefits to existing airspace users and airports posed by unmanned traffic (drones);
- Research analyst resource to cater for the bare minimum level of strategic research in new and emerging technologies, for example, increased ATC task automation. They also cover concept development and validation of technology due for deployment in the long term investment plan (LTIP). Without this kind of investment, the scope for further increases in ATCO productivity in RP4 and beyond would be significantly reduced, while the delivery of LTIP projects would face increased risk; and
- Support for developing our future ATM capability to ensure that we can keep pace with technological development to de-risk our investment plans and deliver future benefits to customers.

While some of these roles relate to management and administration, many roles reflect the critical skills required in our business to enable us to deliver the required levels of safety and service performance. A number of these are expert roles, many requiring professional qualifications and include a number with critical safety accountabilities, without which we could not deliver our plan outcomes. Where efficient and appropriate, we plan to utilise these grades rather than more expensive or scarce resources, for example, ATCOs or engineers.

The safety, service, resilience and environmental performance we deliver depends on ATCOs, ATSAs, engineers and a wide range of other professionals and support staff who are an important part of our business. They support the day-to-day operation and the evolution of our service in areas such as:

- Safety;
- Operational resourcing;
- Programme management - airspace modernisation, technology programme, move to one operation;
- Change management;
- Training and simulation;
- Supply chain management; and
- IT security, governance and assurance, finance and HR.

Appendix L: Our airspace and technology programmes

Introduction

This appendix presents a high level summary of our core investment proposals for RP3, based on consultations with customers, the CAA's expectations and European Commission (EC) requirements, which include building on the technology strategy set out in RP2. While it is written to be accessible by as wide an audience as possible, it is most likely to be of interest to customer and regulatory stakeholders who have a particular interest in our investment portfolio, for example, those who engage in the Service and Investment Plan (SIP) consultations.

This description of the portfolio is structured in four main sections:

> The rationale for the portfolio, building on the key drivers including the key benefits we expect to be delivered;

> An overview of the portfolio, including the high level milestones, overall costs and key portfolio risks and dependencies;

> Our approach to benefits management and more detail on the key benefits that will be realised by delivery of the portfolio; and

> Information about each programme, complete with financial estimates, risks, dependencies and a summary of key benefits.

Rationale for the portfolio

In developing our approach to RP3, we recognised the importance of understanding significant strategic drivers, such as the context in which we are currently operating. The needs of our customers are of prime importance, but we also considered the fast paced traffic growth; the Future Airspace Strategy (FAS); and current and future regulation and legislation, including the European SESAR legislation and NERL Licence Condition 10[1].

Our strategic analysis identified the need to change the way we operate and deploy new technology, techniques and concepts in order to keep pace with current and future trends in the external environment and wider ATM industry. This analysis was conducted in the context of part of our strategy for investment in new technology during RP3 having been already set out during RP2.

The choices made in support of deploying SESAR in RP2 recognised the need to replace our older systems and accelerate the deployment of new technology. Our plan is aligned with the European ATM Master Plan and is designed to improve service resilience, enable the modernisation of airspace and enable us to meet our legal obligations under European and UK legislation.

The plan is supported by analysis that indicates that the benefits brought by airspace change can only be enabled by new technology. This is illustrated in the chart below that forecasts the impact of the RP3 plans across three cases and is inclusive of investment in additional ATCO resource in all three cases:

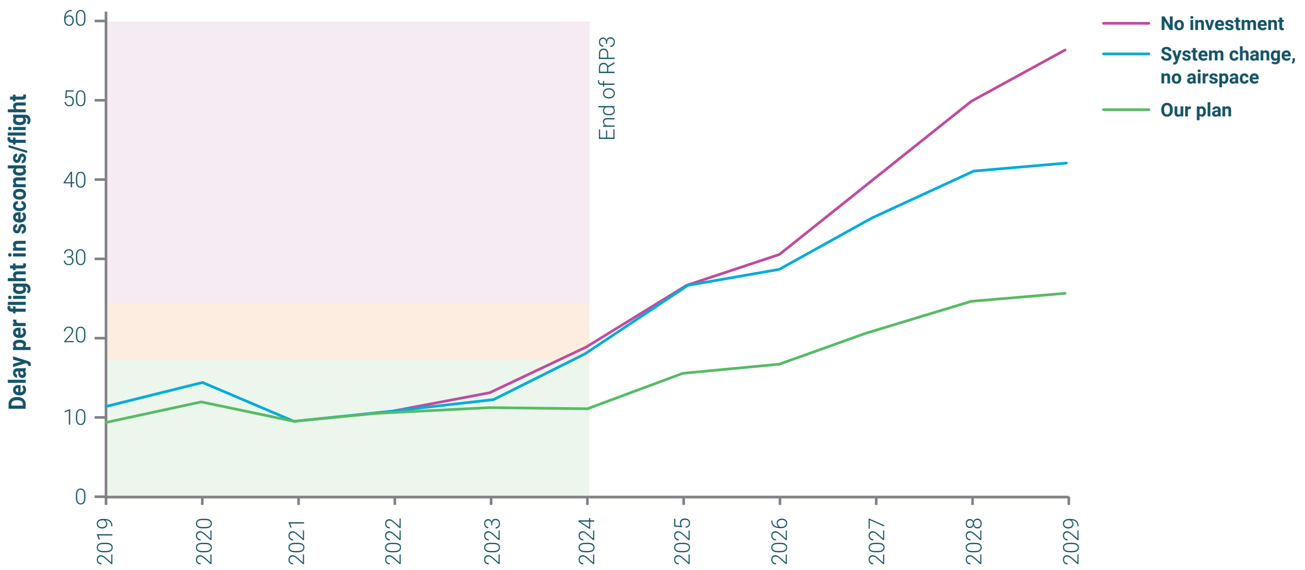
1. No investment from today, on the assumption that current systems could be maintained;
2. Investment in new technology only; and
3. Investment in new technology and systemisation of airspace.

The implication of no investment, or even limiting investment in new technology, is clear. The trend for the first two options, based on assumed traffic growth, indicates significant delay leading into RP4, and a major challenge to our ability to recover service delay to acceptable levels at the end of RP3 and into RP4. The benefit of investing in people (ATCOs), processes (airspace change) and technology (DSESAR) is unambiguous, and opens the way to further investment in RP4 to maintain current service levels.

The chart also demonstrates the interconnected nature of the plan. There is a clear dependency between new technology and the effective service delivery that will be enabled by airspace change. We believe we have investigated trade-offs to ensure the plan is appropriately balanced in order to meet the major requirements for airspace change supported by technological change. We have also conducted numerous assessments to ensure that the impact of the rate and scale of change on current operations is limited to the greatest extent possible, building on the lessons learned alongside our customers during the deployment of ExCDS in RP2.

[1] Our Licence Condition 10 (8) states: By 30 June 2018, or any later date agreed with the CAA, the Licensee shall provide the CAA and publish, an outline of options for implementing lower level airspace changes in the London terminal and related airspace redesign area in the period January 2020 to December 2024.

RP3/4 C2 delay forecast



These plans also deliver the right capabilities for the continued traffic growth in RP4 and incorporate and manage the introduction of a range of new and different airspace users. We expect to be guided by Single European Sky (SES) ambitions and those of the proposed ATM masterplan performance, which are challenging. Other wider challenges that we expect during RP4, include a growth in drones - PwC predicts the number of commercial drones in the UK to be 76,000 by 2030 - and airspace users that push the limits of current ATM. These include air platforms that operate at much higher altitudes and speeds, as well as defence platforms that utilise stealth technology.

Our response to these challenges will require continued development of our new systems to increase capacity of the network through the roll-out of advanced tactical management tools in lower airspace. These tools will reduce workload per flight and improve safety levels. We will also implement enhanced decision support tools to assist in planning and improve controller resource utilisation. The investment in system wide information management (SWIM) technologies will enable us to continue to improve routeing and level flexibility, and support the integration of improved arrival and departure management tools. The transition of our service to platform based technology in RP3 will improve resilience and reduce disruption, and allow us to avoid big transitions and thereby reduce risk.

In summary, there is a compelling argument for our RP3 plan to continue with the acceleration of the deployment of modern systems that support the new operational concepts and modern airspace designs: it will meet customers' needs and continue to deliver better performance than the other major European ANSPs.

The overall approach of our business plan is to set out what we need to do to deliver our service day-to-day and to evolve our service to meet our performance objectives, now and in the future. This framework is illustrated diagrammatically in the chart below:

Our aims: A safe, efficient and reliable service day-to-day and to evolve our future service

What we will deliver

- Safety
- Service delivery
- Environment

= RP2 performance with ↑ traffic

- Average price → ↓ 14% compared to RP2 in real terms

How we will deliver day-to-day

- Safety management
- Strategic and tactical planning
- Resourcing and training
- Environmental performance
- Operational, technical and business resilience

How we will evolve our service

- Safety strategy
- Modernising airspace
- New technology
- Evolving our ATM service
- Modernising engineering
- Integrating operations

What we will deliver

The overall performance targets for RP3 provide a key context for our change portfolio. An important objective of portfolio management is to identify, understand and manage the benefits that will be realised through the programmes in RP3 and beyond. The benefits from some improvements will not be fully realised until RP4.

The plan is highly connected and the realisation of benefits relies on delivery of our core plan. To support this, we have introduced a Portfolio, Programme and Project capability (P3O) with responsibility for overall management of the investment portfolio, including the creation of benefits panels and the associated processes of benefits tracking.

The key benefits we expect to deliver are outlined by type in the table below. They will contribute to meeting our proposed targets:

Benefit type	Expected performance range	Measure
Safety	6 – 9%	% reduction in RAT points per 100,000 flights
Service	6 – 9	Reduction in sec/flight
Environment (fuel)	100 – 150	Enabled fuel savings kT
Environment (3Di)	1.00 – 2.00	Reduction in 3Di points
Technical service risk	140 – 160	Reduction in £m net weighted value
Legislative compliance	Compliance across period of RP3	SESAR EU mandatory functionality
Cost efficiency	Contribution to 5% reduction	% DUC

How we will deliver day-to-day

Our ability to deliver day-to-day relies on the availability and resilience of our existing systems. In response to this driver we have defined two programmes within the change portfolio:

> Technical resilience; and

> Business resilience.

How we will evolve our service

Our ability to deliver the service in the future relies on our ability to deliver on the six strategic themes identified in the chart, which are described in the body of the business plan. In response to these strategic themes we have defined five corresponding programmes that will deliver the required changes. These are:

> Modernising airspace delivered by the Airspace Programme;

> New technology delivered by the DSESAR Programme;

> Evolving ATM service delivered by the Domestic En Route Programme;

> Modernising engineering delivered by the Service Orientation Programme; and

> Integrating operations delivered by the Operations Integration Programme.

In addition to the seven programmes identified above, one final programme is required within the portfolio - the Oceanic Programme. This is identified separately as it forms part of a separate service line and falls under slightly different regulatory governance arrangements. It should be noted that our safety strategy is designed to be delivered across our change portfolio, which we describe in more detail below.

Portfolio overview

Driven by the responses to our key aims of delivering day-to-day service and evolving our service for the future, we have created an overall change portfolio structured around eight key programme areas, these are shown in the chart. Each of these programme areas is explained below.

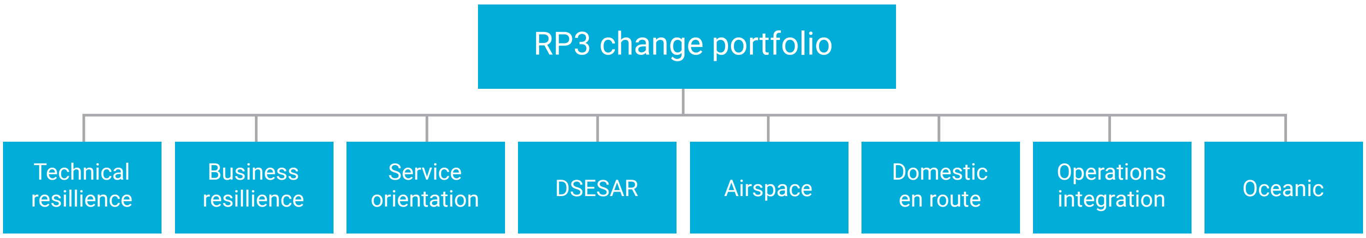
The introduction of a P3O capability through a Portfolio, Programmes and Projects Office has created a stronger internal management and governance framework, with a clear focus on delivering agreed benefits to costs and timescales. This should continue to provide a greater level of confidence in the delivery of key milestones and, as plans develop, provide enhanced levels of information to our customers and stakeholders.

It should be noted that at this stage of development in planning with a portfolio looking seven years ahead, while the overall programmes and high level outcomes are understood, the underlying detail in some areas, including benefits assessments, will undergo further development. Therefore, benefit assessments, as well as exact planning timescales and milestones, are subject to change. Similarly, we may launch and manage a number of programmes to ensure the efficient implementation and alignment of benefit delivery. We would do this through the programme areas described below.

Our total RP3 investment is planned to be in the range of £725m - £800m. The core plan is based on a detailed estimate for the investment portfolio of £763m, including £23m that we propose to accelerate from RP3 into RP2. This would enable early work to secure the delivery of a key technology milestone (DP Lower) in 2022. It would also de-risk the subsequent systemisation of lower airspace. Any changes will be managed by our P3O capability, which will make appropriate decisions based on forecast outcomes to optimise the right balance of benefits and risk mitigation. Where any such changes occur, we will communicate and engage with our customers and stakeholders through the agreed and updated SIP process. See Chapter 9 for more detail.

The P3O capability will manage investment to provide the most efficient use of resource, maximising value for money. This includes the adoption of improved methods for estimating time and resource in a complex portfolio at programme and project level, which will enable more accurate and refined planning. This will support us in maintaining our rigorous approach to seeking value for money from contracting.

Much of the investment plan will be delivered through our key suppliers and partners. In line with leading procurement and contract management techniques, and using standards such as ISO 440001, we have in place performance measurement and management of our most important suppliers and partners. This is built around ensuring delivery and also identifying and driving savings and efficiencies. It includes ensuring good working relationships between our suppliers themselves thereby ensuring integration costs are optimised. Our supply chain management team use a range of techniques to support value for money, including competitive tendering and where the sourcing strategy points to a single source, we have undertaken extensive benchmarking including using independent value for money assessments to drive our negotiations and subsequent contract awards. A sourcing review panel provides oversight of the sourcing process to provide governance and challenge.



Programmes

Airspace

The proposed programme for airspace will draw on the capabilities provided by new technologies to deliver the principal changes and benefits required by customers. It is an ambitious programme and uppermost is the design and implementation of significant airspace change across the south east and Manchester regions through the systemised airspace programme. It will, in conjunction with the delivery of free route airspace (FRA), enable us to use the advanced tools delivered by DSESAR, such as iTEC[2] ExCDS[3] and FourSight[4] to provide true performance based navigation (PBN). This is the most significant dependency for airspace.

The programme will require the development of new standard instrument departures (SID), standard terminal arrival routes (STAR) and transitions to create a fully modernised airspace and facilitate a third runway at Heathrow. It will be supported by a variety of queue and capacity management tools such as time based separation (TBS), arrivals manager (AMAN) and extended arrivals manager (XMAN). We are aware that there is a significant external dependency on airports to agree and deliver their respective changes in support of the systemisation of lower airspace.

A synchronised airspace change of this scale will require the commitment of the Department for Transport (DfT) and the CAA. In our wider plan we propose that we manage the change on behalf of the aviation industry. See Chapter 7 for more details.

[2] Interoperability through European Collaboration is a joint endeavour between ANSPs and INDRA (a technology industry leader in this sector). The ANSPs are: NATS, LVNL (Netherlands), DFS (Germany), ENAIRE (Spain), AVINOR (Norway), Oro Navigacija (Lithuania) and PANSA (Poland). iTEC is leading on the development of technology such as the flight data processing system and controller working position required for new technology.
[3] ExCDS is an electronic flight-strip solution that provides controllers with key information about aircraft entering and using their respective sectors of airspace.
[4] FourSight is a tool being developed by Altran that will enable trajectory planning across UK airspace.

Domestic en route

This programme provides investment to deliver small scale, operational capability improvements (safety, capacity or environmental benefits) in support of wider airspace systemisation, system enhancements, and the agility to deliver rapid airspace change to address hot spots.

DSESAR

This is at the heart of our investment plans and is one of the fundamental building blocks necessary to complete the technical strategy agreed in RP2 and ensure our service will be fit for purpose in the future. In order to complete the deployment of the common method of operations and platform across the en route operation, and deliver iTEC, ExCDS and Voice over IP (VoIP) into lower airspace, the DSESAR programme will enable the decommissioning of older technology to complete the removal of our older systems.

The programme is forecast to remain within an envelope of £750m to £830m across RP2 and RP3 (outturn prices) to complete deployment of the DSESAR platform and to remove key legacy systems as previously agreed through the SIP process. It is the key enabler for the systemisation of airspace and our aim is to deliver this change as swiftly and safely as possible. It will also enable the service orientation and operations integration aspects of the portfolio described below. These will, in combination with DSESAR, help us to deliver a more efficient service.

It is also key to meeting the EU SES objectives mandated by the Pilot Common Project (PCP) and other implementing rules, through the delivery of modern tools such as iTEC and FourSight that will enable changes such as FRA. In addition, the ability to generate greater sharing of system information through SWIM will improve the extent of collaborative decision-making used across the network.

Technical resilience

This programme seeks to maintain sufficient investment to deliver a robust and resilient level of service, legislative compliance, operational performance and cyber resilience. We plan to deliver investment through two separate lines of development:

> Centres and builds sustainment and remote sites; and

> Communications, navigation and surveillance (CNS).

The first will sustain the national airspace system and NAT operational display equipment (NODE) until we transition to the common platform in 2022. There will be support throughout for aeronautical information regulation and control (AIRAC[5]) updates and the implementation of cyber resilience enhancements. We will retain appropriate skill sets and resources so that we can pivot to sustaining the common platform in 2022.

The second will deliver support and mid-life upgrades to CNS infrastructure to ensure compatibility with other systems that are being delivered through DSESAR and the capability that will be required into RP4 and beyond.

Business resilience

We are required to retain appropriate levels of business resilience. This programme supports this through two lines of development:

> Facilities management; and

> Information solutions.

Facilities management includes property services, building and engineering services, environment (we have committed to reduce estate CO_2 emissions by 30% by 2024 compared to a 2015 baseline) and health and safety. Information solutions are an essential component of business resilience that ensures that we can meet the business IT needs of our users. The increase in the cyber threat to the business, reflected in revised legislation, requires the implementation of upgrades and new services to meet the needs of the business.

Oceanic

This programme seeks to emulate the progress that will be delivered by the modernisation and systemisation of en route and lower airspace, by utilising space-based automatic dependent surveillance-broadcast (ADS-B[6]) surveillance supported techniques to reduce separation requirements and introduce user preferred trajectories into high level airspace. These changes, in conjunction with a traffic and workload management capability in oceanic airspace, will enhance safety, increase capacity and reduce aircraft fuel burn. It will also facilitate the development of revised route charging tools that will be necessary to match the capabilities provided by ADS-B surveillance, offering improved assurance to customers. See Appendix M for more details.

[5] AIRAC is an ICAO standard for the update and change of airspace based on a 28 day cycle.
[6] ADS-B is a surveillance technology which allows an aircraft to broadcast its position, enabling it to be tracked via ground or space-based sensors.

Service orientation

This will transform our organisation into one based on service orientation through the service operations strategy. It will also apply the principles of service management, based on the market-standard ITIL framework, to all operations.

It will enable the engineering support team to adopt service-led principles and use service operations management tools that will improve the quality of customer service through closer links with operational services. Customers will benefit from a proactive, more automated service that leverages common practice, engenders continuous service improvement, increases resilience and will ultimately drive out cost efficiencies. Note that this programme is revenue based and not included in the capital costs summary.

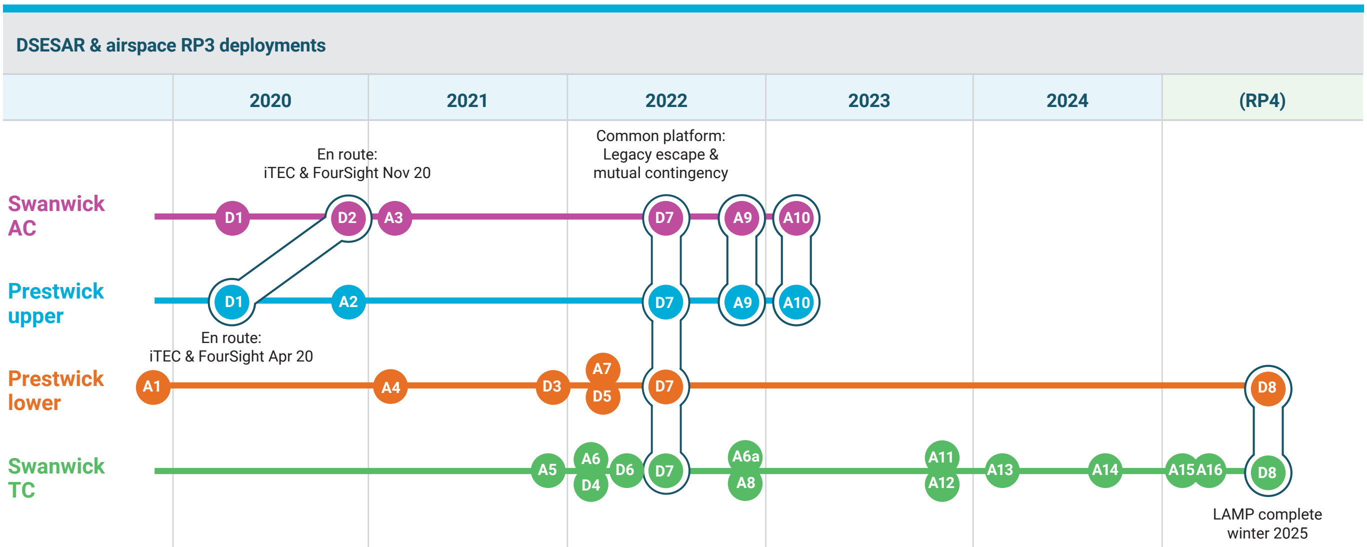
Operations integration

In order to realise the benefits from the common platform and airspace modernisation, there are a number of significant changes that need to be delivered to our operations to reach the One Operation – Two Centres vision. The majority of cost is likely to be incurred as revenue, as much of this change programme will be delivered through changes to operational procedures and practices.

It is also likely to entail organisational alignment and revised workforce planning, which will provide more flexible resources. We will be less constrained in deploying our resources than now, and will be able to safely match resources to customer demand. We anticipate this will increase safety by aligning operational procedures and training, and through greater mutual contingency. The standardisation of training will enable us to adopt tools or airspace change faster, and we plan to maintain service levels while delivering cost efficiency. Note that this programme is revenue based and not included in the capital costs summary.

High level plan and investment

The programmes described above represent the high level scope and ambition within the RP3 change portfolio. The key milestones within the portfolio, primarily within the airspace and technology programmes, are shown in the high level plan provided below. There is one noteworthy change to our previous schedule: deploying DP En Route in two transition phases in 2020 rather than one phase in April 2020. This provides a smoother transition, carrying less risk than would be expected from a single transition across both centres. Further detail is provided in the DSESAR programme overview.



D: DSESAR

1. AC voice comms
2. iTEC & FourSight operational for en route
3. Selected PC lower sectors to en route system
4. Selected TC sectors to en route system
5. iTEC & ExCDS PCLA
6. iTEC & ExCDS TC
7. Common platform: legacy escape & mutual contingency
8. iTEC & FourSight operational lower airspace

A: Airspace

1. PC lower airspace systemisation
2. PC free route airspace (selected sectors)
3. Initial dynamic sectorisation
4. AMAN expansion to Manchester
5. AMAN expansion to Stansted
6. Independant parallel approach (IPA)

6a. Heathrow IPA early morning

7. PLAS Manchester TMA
8. TBS Pairwise
9. Free route airspace (Swanwick & PC complete)
10. Advanced flexible use of airspace
11. TBS Gatwick (mixed mode)
12. LAMP enabling changes
13. LAMP (Phase 1)
14. LAMP (Phase 2)
15. LAMP (Phase 3)
16. LAMP (Heathrow R3 deployment)

The table below shows a more detailed breakdown of the high level plan, with descriptions and expected outcomes. The table also shows where the milestones contribute to our commitment to meeting regulatory requirements under the PCP legislation EU (716/2014).

Ref	Date	Milestone	Description & outcomes	PCP Reference
D0	Early 2019	Core infrastructure for DSESAR platform	Deployment of the core infrastructure to support DSESAR, underpinning all future DSESAR deployments. Provides a resilient platform initially used for testing, validation and training.	Platform to support PCP compliance: AF1, AF2, AF3, AF4, AF5, AF6
			Dual running costs for the new platform alongside existing infrastructure commence at this point.	
A1	Late 2019	PC lower airspace systemisation	Commencement of delivery of improvements to the overall efficiency of the lower airspace within Prestwick Centre's area of responsibility, in line with the CAA's FAS and using SESAR concepts.	AF1
			Increased capacity and improved environmental/fuel efficiency.	
D1	Feb 2020	AC voice comms	Deployment of the new main voice system utilising voice over IP communications together with a higher performance backup system.	
			This reduces the risk associated with the existing voice system which is end of life, provides increased resilience to failure and increases flexibility of operations.	
D2	Apr2020 & Nov 2020	iTEC and FourSight operational for en route	Deployment of new ATM capability for the whole of UK upper airspace, incorporating iTEC, flight data processing (FDP) and FourSight trajectory tools supported by the new common platform. We plan to transition Prestwick in April 2020 and Swanwick in November 2020 in order to provide a smoother transition into service.	AF3, AF4, AF5
			Provides increased resilience and flexibility delivered by the new platform as well as increased safety and efficiency enabled by the trajectory based operations. Enabler for further developments including free route airspace and initial dynamic sectorisation.	
A2	Late 2020	PC free route airspace (FRA) (selected sectors)	Initial deployment of FRA in eight selected sectors covering most of Prestwick airspace.	AF3
			Delivers customer fuel savings and improved predictability and is an enabler for initial dynamic sectorisation.	
A3	Early 2021	Initial Dynamic Sectorisation	First stage of a sequence of phased deployments leading to full dynamic sectorisation capability, which makes use of the common platform to allow changed configuration of sectors within and between centres. Initial dynamic sectorisation focuses on more effective band-boxing and splitting of sectors.	AF3
			Delivers increased flexibility in managing airspace allowing for increased efficiency in rosters.	
A4	Early 2021	AMAN expansion to Manchester	Deployment of arrival management capability for Manchester airport subject to co-ordination with Manchester airport who have primary responsibility for this deployment as provider of the approach function.	AF1
			Improved sequencing and management of aircraft leading to reduced holding and associated fuel burn. Enabler for extended AMAN introduction (XMAN).	
A5	Late 2021	AMAN expansion to Stansted	Deployment of arrival management capability for Stansted airport.	AF1
			Improved sequencing and management of aircraft leading to reduced holding and associated fuel burn. Enabler for extended AMAN introduction (XMAN).	
D3	Late 2021	Selected PC lower sectors to en route system	Move selected sectors from Prestwick lower airspace on to the en route system.	AF1
			Deliver additional capacity and flexibility in the affected sectors and helps to de-risk milestones D4 and D5.	
A6	Early 2022	Independent Parallel Approach (IPA)	IPA will improve the current two–runway operation at Heathrow. Significant enabler for systemisation.	AF1
			Increased capacity.	
A7	Early 2022	Prestwick lower airspace systemisation (PLAS) Manchester terminal manoeuvring area (TMA)	Final stage of PLAS focusing on Manchester airspace including a point merge approach.	AF1
			Increased capacity and improved environmental/fuel efficiency.	
D4	Early 2022	Selected TC sectors to en route system	Move selected sectors from TC airspace on to the en route system.	AF1
			Deliver additional capacity and flexibility in the affected sectors and helps to de-risk milestones D4 and D5.	

Ref	Date	Milestone	Description & outcomes	PCP Reference
D5	Early 2022	iTEC & ExCDS PCLA	Deployment of new ATM capability for the whole of PCLA, incorporating iTEC FDP and ExCDS electronic flight strips supported by the new common platform.	AF5, AF6
			Provides increased resilience and flexibility delivered by the new platform as well as increased safety and efficiency enabled by the trajectory based operations. Enabler for further developments including new procedures and airspace design and future FourSight deployment.	
D6	Early 2022	iTEC & ExCDS TC	Deployment of new ATM capability for the whole of TC airspace, incorporating iTEC FDP and ExCDS electronic flight strips supported by the new common platform.	AF2, AF5, AF6
			Provides increased resilience and flexibility delivered by the new platform as well as increased safety and efficiency enabled by the trajectory based operations. Enabler for further developments including LAMP and future FourSight deployment.	
D7	Mid 2022	Common platform: legacy escape & mutual contingency	Completion of the common platform across Swanwick and Prestwick allowing for removal of previous generation of existing systems and achievement of legacy escape.	AF5
			Introduction of mutual contingency (for catastrophic failures) between the two centres. End of dual running costs associated with running the legacy system and new platform in parallel.	
A6a	Late 2022	Heathrow IPA early morning	Enhancement of IPA will improve the capacity of the current two-runway operation at Heathrow.	AF1
			Increased capacity.	
A8	Late 2022	TBS pairwise	Enhancement of TBS to support static pairwise wake vortex separations based on individual aircraft types.	AF2
			Increased landing rate for Heathrow airport yielding increased capacity or reduced stack holding and associated fuel burn.	
A9	Late 2022	FRA (Swanwick and PC complete)	Final stage of phased deployment of FRA in Swanwick and Prestwick airspace.	AF3
			Delivers customer fuel savings and improved predictability and is an enabler for initial dynamic sectorisation.	
A10	Early 2023	Advanced flexible use of airspace	This will enable improved capacity and safety within UK controlled airspace.	AF3
A11	Late 2023	TBS Gatwick (mixed mode)	Deployment of mixed mode TBS for Gatwick airport.	AF2
			Increased landing rate for Gatwick airport yielding increased capacity or reduced stack holding and associated fuel burn.	
A12	Late 2023	LAMP enabling changes	Deployment of preparatory changes to prepare for and enable LAMP changes in subsequent milestones.	AF1
A13	Early 2024	LAMP (Phase 1)	LAMP deploys a revised network design for the whole of London terminal airspace and linked to potential related developments in 13 airports.	AF1
			Deployed in up to three phases: first phase, dependent on the scope and complexity of enabling changes will modernise parts of the London TMA airspace design based on performance based navigation (PBN) routes and delivering additional capacity and fuel benefits.	
			Network and transition designs will not be determined until the final months of RP2.	
A14	Late 2024	LAMP (Phase 2)	LAMP deploys a revised network design for the whole of London terminal airspace and linked to potential related developments in 13 airports.	AF1
			Deployed in three phases: second phase incorporating significant portions of the TMA and other airports linkages to the London TMA.	
			Will contribute to a modern airspace design based on PBN routes delivering additional capacity and fuel benefits.	
A15	Early 2025	LAMP (Phase 3)	LAMP deploys a revised network design for the whole of London terminal airspace and linked to potential related developments in 13 airports.	AF1
			Deployed in three phases: third phase completes all south east airspace changes including preparatory work for R3.	
			Modern airspace design based on PBN routes and delivering additional capacity and fuel benefits.	
A16	End 2025	LAMP (Heathrow R3 deployment)	The deployment of R3 departure and arrival routes into the systemised LAMP airspace subject to government decision.	AF1
D8	Early 2027	iTEC & FourSight operational for lower airspace	Deployment of FourSight trajectory prediction, conflict detection and conformance monitoring into lower airspace.	AF6
			Tool support is an enabler for realising additional benefit from the systemised airspace created by LAMP.	

The ATM functionalities included in the PCP and referenced above are listed below.

AF1	Extended arrival management and PBN in the high density TMAs
AF2	Airport integration and throughput
AF3	Flexible airspace management and free route
AF4	Network collaborative management
AF5	Initial SWIM
AF6	Initial trajectory information sharing

The proposed RP3 change portfolio to deliver these outcomes totals £763m, which represents around 8% of our price. The table below shows a breakdown of capital investment costs by programme and year.

Programme capex (2017 prices)	2020 £m	2021 £m	2022 £m	2023 £m	2024 £m	RP3 £m
Airspace	17	34	31	21	12	115
Delivering capability (DSESAR)	117	85	16	18	64	299
Technical resilience	25	27	35	31	26	144
Domestic en route service improvement	9	6	8	8	5	37
Business resilience	22	18	17	17	13	88
Oceanic ^	*4*	*2*	*5*	*1*	*3*	*15*
Total NERL forecast	**195**	**173**	**112**	**96**	**123**	**698**
*Military **	*2*	*2*	*2*	*2*	*2*	*8*
Total forecast	**197**	**174**	**114**	**97**	**124**	**706**
Contingency		5	8	8	13	34
Total forecast including contingency	**197**	**180**	**121**	**106**	**137**	**740**
Accelerated to RP2						23
Total including RP2 acceleration						**763**

^ Oceanic programme subject to oceanic specific customer consultation.

* Military programme subject to agreement with MOD under future military radar services contract.

Benefits management

We have made an assessment of the strategic drivers of the business, with a close focus on customer and regulatory requirements, in order to frame the context within which RP3 will be delivered. This, in turn, has identified the five major strategic themes for evolving our service, described in more detail below. We have taken these themes forward, and focused and framed them in realistic targets for RP3 (see Chapter 5), which are outlined below:

Proposed RP3 service quality term	Proposed RP3 service quality description	Proposed RP3 target
C1 service	Average delay per flight at the NATS/IAA FAB level (seconds)	13.8
C2 service	Average delay per flight (seconds)	10.8
C3 service	Impact score (mitigated – weighted seconds per flight)	23.8
C4 service	Variability score (mitigated – weighted seconds per flight)	2000
E1 flight efficiency	3Di score	16.2-17.9

These have enabled us to focus the broader requirements and frame them in realistic benefit outcomes (noted in broad terms above) that will be delivered through a series of projects and programmes by the change portfolio. There are six benefit types:

> Safety: Investments that reduce the likelihood of a serious or risk bearing incident in UK controlled airspace to help achieve our high level internal safety target for RP3, to maintain or improve safety levels by ensuring that the number of serious or risk bearing incidents per flight does not increase and where possible decreases. Quantified as a percentage reduction in risk analysis tool (RAT) points per 100,000 air traffic movements);

> Service: Investments that deliver additional capacity, provide service resilience, maintain runway servicing rates or reduce delay. The benefit measure is quantified by the number of seconds saved per flight that will be enabled by the investment. This is linked to the C2 service measure;

> Environment: Investments that enable our customers to reduce their fuel burn by enabling more direct routeing, less holding and more optimal flight levels. The benefit measurement is tonnes p.a. of fuel savings enabled. This is linked to target reductions in the 3Di service measure;

> Cost efficiency: Investments that enable our cost reductions that can be realised as a contribution to reductions in the determined unit cost as outlined in our business plan;

> Legislative compliance: Investments that allow us to meet our Licence obligations, international mandates or implementing rules. In many cases, such investments may also deliver other benefits too; and

> Technical service risk: We own and operate in excess of £1bn of assets that need to be maintained and upgraded to maintain performance. Investment is undertaken solely for sustainment purposes if the financial impact assigned to the risk is greater than the investment. The benefit measurement is the reduction in the net weighted value of risk.

Benefits governance

The proposed targets and six benefit types will be governed through a robust and resilient P3O methodology led by the P3O office, which has overall responsibility for management of the portfolio, including the creation of benefits panels and the associated processes of benefits tracking. The P3O provides detailed portfolio information, including supporting business case development, which is assessed through a range of governance levels through the benefit delivery panels, portfolio management meeting (PMM), the Portfolio Investment Board (PIB), and the Technical Review Committee (TRC), and Board. Their main functions are described below.

Benefit Delivery Panels

There are six benefit delivery panels each of which is chaired by a senior member of management. The chairperson has accountability for setting benefit targets, and tracking individual programmes and projects, in order to deliver the benefits as driven by the RP3 strategy and plan. They are also responsible for ensuring that:

> There is appropriate evidence of benefit delivery;

> Changes to current status are impact-assessed;

> Future initiatives are impact-assessed and appropriate requirements placed in the business to deliver these;

> Consistent, robust methodologies for calculating benefits are maintained and utilised; and

> They communicate with the other benefit delivery panels to ensure cross-panel issues are understood and managed.

Portfolio Management Meeting (PMM)

The role of the PMM is to receive monthly updates from the benefit panel owners who report on the status of benefits delivered. It is chaired by the technical services director, supported by his senior management team and representation from across the wider business. It assesses portfolio information provided by the P3O in order to provide recommendations to the PIB and makes decisions that impact on the portfolio, such as new investments, resource capacity, and additional funding or change requests.

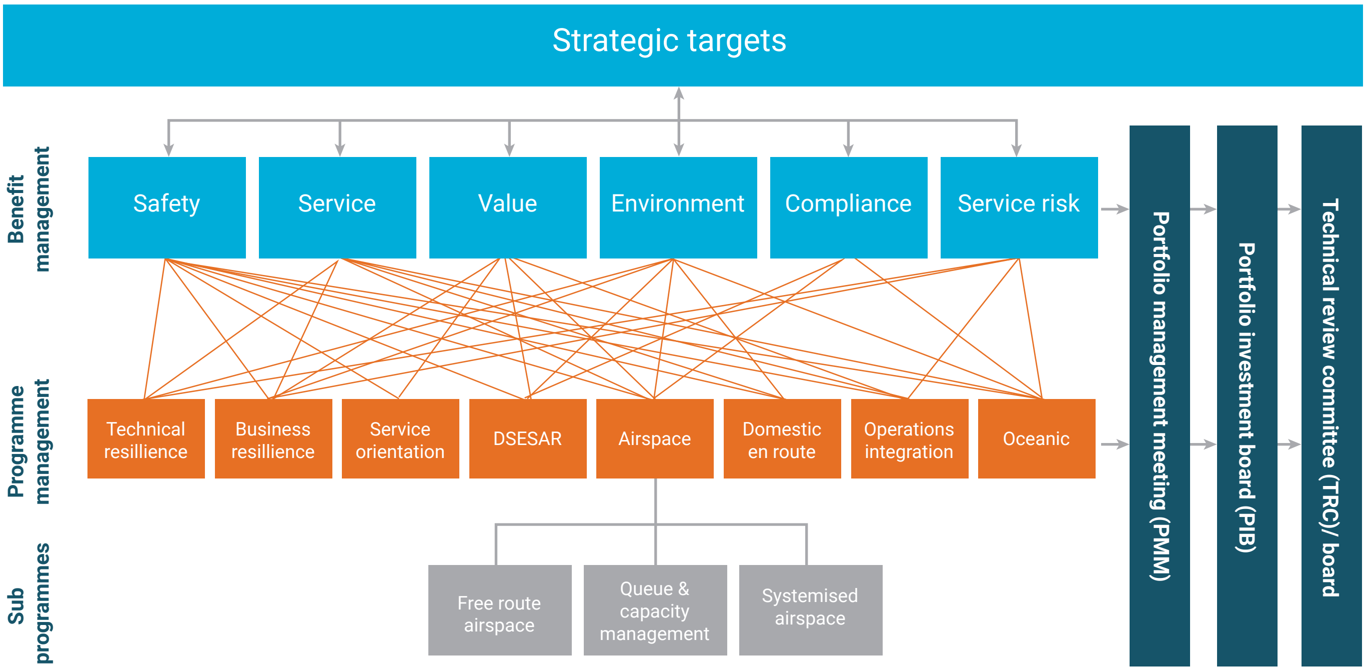
Portfolio Investment Board (PIB)

The PIB examines and assesses business cases endorsed by the PMM that require greater scrutiny, based on the value of the overall business case. It is chaired by the CEO and supported by the finance director and three lead executive directors. The PIB will also endorse any business cases that require scrutiny by the Board. It meets monthly.

Technical Review Committee (TRC)

The TRC meets quarterly and aims to review and endorse all Board-level business cases.

This structure is illustrated below:



The anticipated base value of benefits to customers is outlined in more detail below. It shows our early assessment of the contributions that will be made towards our targets in RP3 against the expected performance ranges already discussed. Customers should be aware that these are our best estimates based on predictive analysis, and that we are continuing to refine these assessments.

We will continue this work through the remainder of RP2, during the planning process, and into the early stages of the programmes as we develop a deeper understanding of how the programmes are defined. We will endeavour to increase the level of benefit that can be realised.

	2020	2021	2022	2023	2024	Overall contribution from programmes	Expected performance range
Safety %	1.2	1*	5.7	1*	3	**7**	**6 – 9*** **
RP3 service secs/flight	**	0	0.2	1.7	7.8	**7.8**	**6 – 9*** **
Environment (fuel) kT p.a.	10	0.3	50	7	90	**157**	**100 – 150*** ***
Technical service risk £m	42	8.8	58.6	21.9	20.5	**151.8**	**140 – 160**
Legislative compliance	Compliance across period						
Cost efficiency	Contribute to 5% reduction in DUC						

*Assumes mitigation of potential safety challenges through implementation of ICAO SIDs/STARs and LAMP Enablers (TA).

** We anticipate a service improvement will be generated by the availability of additional staff at the start of RP3.

*** Separately delivered benefits cannot always be added due to broader network effect.

**** Total for UK domestic programmes only.

Risk and dependency management

We have a well defined and robust risk management process that enables us to capture risk at a variety of levels, and assess and manage it in the most appropriate way. We take a consistent approach, using a standardised risk register, which allows users to record full details about each risk in a central database. This, in turn, supports the business risk management process which, depending on the significance of the risk, is reported and managed by the governance bodies - PMM, PIB and TRC - and ultimately to the Board via the Audit Committee.

There are a number of risks that are associated with the delivery of the change portfolio. The most significant of which are:

> Technical (risk of system failure): We continue to operate on ageing operational technologies and platforms which are increasingly difficult to maintain and support. These systems are currently stable, but there is an increasing risk that these systems will become unsupportable or incapable of meeting traffic demand. The impact of failure could prove detrimental to both our service and safety, depending on the time it takes to resolve any issue.

  – We mitigate this risk through the technical resilience programme and will ultimately resolve it through the delivery of DSESAR technology.

> Legacy escape delay: A delay to the delivery of system solutions through the DSESAR programme to replace ageing systems would present a risk that additional time, funding and extended maintenance support would be required. This would potentially lead to an increased need for investment or support funding.

  – This risk is mitigated through very close tracking and senior management oversight of the DSESAR programme.

> Supplier performance: Our dependency on the performance of a limited range of suppliers, rather than internal staff for the development of core systems, could result in a risk of delay to the delivery of systems. This would lead to delays to the delivery of core systems and increased supplier costs.

  – This risk is mitigated through intense collaboration with suppliers, including careful evaluation of tenders and the imposition of detailed contracts. Further mitigating measures include: embedding our staff in the suppliers' organisations, and senior level weekly and monthly reviews of suppliers' progress.

> Regulatory requirements change: Political or environmental change in RP3 may change the scope or timescale for meeting or maintaining compliance. Change in regulation may mean some work or change could be futile. This has the potential to increase costs to meet the change in scope or wasted effort.

  – We continue to work closely with the CAA and the EU (notwithstanding Brexit) in order to have early warning on potential changes to regulation.

> Airspace consultation failure: Where airports and/or the CAA/DfT take longer than envisaged to reach a decision on consultation requests, or reject the request, there is a risk that airspace initiatives will be delayed. This would impact on the delivery of associated benefits and potentially increase costs through re-work or redesign.

  – We continue to work closely with the CAA, local government and industry to develop a methodology appropriate for the significant change planned in RP3 to mitigate this risk.

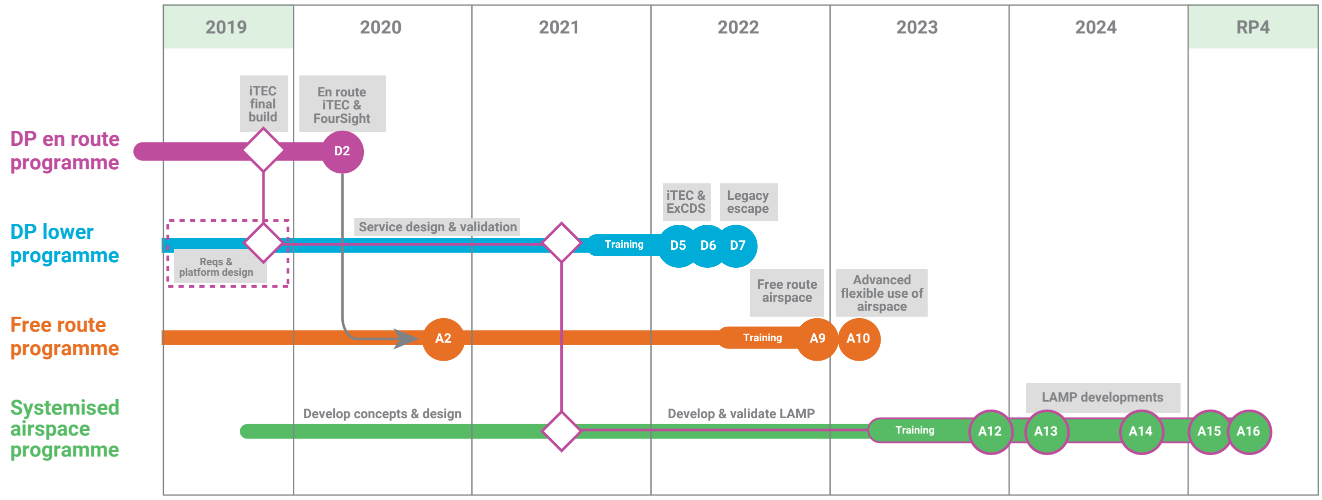
The change portfolio is highly connected, and we have made sure that we identify and manage the dependencies across the portfolio. The key milestone for RP3 is the design and delivery of LAMP, as this is the major contributor for the delivery of benefits, and will meet the requirements of FASI- South through the systemisation of airspace. Given its importance to our plan, there are internal and external dependencies related to the airspace consultation failure risk noted above. The major internal technical and training dependencies are illustrated below.

The key thread is the delivery of the DSESAR platform. In order to ensure a safe and ordered deployment, we have phased its delivery from the technical availability of the platform at the start of DP En Route in April 2020 and then DP Lower in 2022. The operational deployment of DP En Route in Prestwick and Swanwick through two transitions in April and November 2020 does not affect the deployment of DP Lower in 2022, which will ensure the delivery of LAMP from 2023 onwards.

This shows not only the level of interdependence across the portfolio in RP3, but also emphasises the bridging from RP2 across RP3 to RP4 to enable the delivery of modernised airspace, which is enabled by modern technology and supported by the modernisation of people skills.

Within DSESAR there are significant dependencies and these are managed via the industry-standard service integration framework. The framework provides a vertical hierarchy of requirements and validation to ensure that there is clear accountability for the layers of technological and service development to enable the monitoring of key deliverables.

RP3 Portfolio critical path and dependies



D: DSESAR

2. iTEC & Four Sight operational en route
5. iTEC & ExCDS PCLA
6. iTEC & ExCDS TC
7. Common platform: legacy escape & mutual contingency

A: Airspace

2. PC Free route airspace (selected sectors)
9. Free route airspace (Swanwick and PC complete)
10. Advanced flexible use of airspace
12. LAMP enabling changes
13. LAMP (Phase 1)
14. LAMP (Phase 2)
15. LAMP (Phase 3)
16. LAMP (Heathrow R3 deployment)

Key dependency

Critical path

Accelerated RP3 funding for DP lower programme essential to maintain critical path

Specific cross-programme dependencies, as noted in the chart above, are managed via a dependency agreement between the relevant programmes and tracked as part of normal reporting.

The main external dependency is the ability to co-ordinate and manage the delivery of the major airspace change required in lower airspace. Although we agree with the necessity of us supporting the CAA's consultation on change with a variety of stakeholders, including 15 airports, we have concerns about the current regulatory process for conducting airspace change proposals that requires us to work with the wider aviation industry without a clear framework in which to do so. We propose that we lead the management of this essential dependency on behalf of the CAA and aviation industry. See Chapter 7 for more details.

It should be noted that this plan, which reflects consultation with our customers and other changes that have materialised over the last six months, is a change programme that has minimal spare bandwidth/capacity and should be considered a challenging plan with little opportunity for flexibility if the key milestones are to be delivered as planned. In particular, the airspace programme has significantly more dependencies on stakeholders and agencies outside of our control.

Overview of programmes

The following pages provide further detail on the scope, spend profile and expected outcomes in RP3 for each of the programme areas. This is a safety and service-led plan with a focus on operational and technical resilience. It focuses on the delivery of DSESAR to sustain and develop systems that enable airspace modernisation, and allows for continued air traffic growth while mitigating environmental effects on emissions and managing noise.

Airspace

The proposed programme for airspace will draw on the capabilities delivered by our new technologies to deliver the principal changes required by customers. The key elements in this programme are FASI-South (LAMP), FRA and queue and capacity management. It is the main programme aligned with the strategic response for modernising airspace. We assess that it has a relatively high maturity but that uncertainty around external dependencies means that the level of programme maturity is limited to medium. A description of these key elements is provided below.

Free route airspace

The aim of the FRA sub-programme is to provide airspace users with the ability to flight plan and fly the most cost effective route of their choice without being constrained by an ATS route network. The SESAR PCP ATM Functionality (AF) 3 Implementing Regulation EU716/2014 states that free route shall be provided and operated in the airspace for which the member states are responsible at and above flight level 310 in the ICAO EUR region. Stakeholders are required to implement the functionality and deploy by 1 January 2022.

In addition, we have committed to the Borealis Alliance FRA Programme to deliver FRA, from Prestwick Centre by the end of 2020, and from Swanwick Centre by winter 2021/2022. The deployment of tools and systems that enable the planned, transparent and optimal sharing of UK flight information region (FIR) airspace will also deliver advanced flexible use of airspace. This will mean that commercial operations will be able to fly optimal routes and Ministry of Defence operations can meet their operational and training requirements.

We will adopt a phased approach to the implementation of FRA in the UK. The initial phase will introduce FRA in eight sectors at Prestwick Centre where the airspace is less dense and less complex. FRA will be implemented in Rathlin, Hebrides, Moray Hi, Montrose North sectors and parts of Tyne and Dean Cross North sectors at FL255.This will enable the cross-border FRA with the Borealis Alliance. After this, we will implement at both Prestwick and Swanwick Centres.

Outline benefits

> Modernising the airspace is an absolute priority for customers and the continued growth of aviation in the UK;

> It will meet political and legislative obligations by meeting SESAR PCP requirements and the undertaking to the Borealis Alliance;

> It will improve predictability in flight time, optimising airline and airport operations;

> It enables delivery of initial dynamic sectorisation which will improve service delivery and assist in balancing controller workload; and

> Initial estimates indicate an approximate fuel saving of 4kT in 2020 (based on initial FRA deployment), with an additional likely 34kT fuel saving by the end of 2022.

Systemised airspace

We will continue to deploy our elements of both FASI-North and FASI-South within the scope of the UK future airspace strategy. PLAS is the deployment of FASI-North. It is expected to be completed in RP3 with the deployment of a redesigned and optimised Manchester TMA.

LAMP is our network level airspace change in support of the deployment of FASI-South across up to 15 airports in the south east. This is vital to the future growth of these airports, particularly against a backdrop of growth in demand and a third runway at Heathrow - the current concept of operations cannot deliver the required increases in capacity. LAMP will be delivered in three phases, subject to precise deployment planning, and completed by March 2025. It will be followed by the deployment of R3 routes in the LAMP design immediately prior to the operation of the runway.

It will continue the early work we have already undertaken for LAMP phase 1, which has improved the approach and departure routes for London City airport. It has also improved operation systemisation to provide a clear and predictable flow of inbound traffic to London City airport, bringing more fuel efficient operations. Due to issues outside our control, we were unable to continue with LAMP in RP2 due to issues, so we adopted a range of airspace changes through the Swanwick Airspace Improvement Programme (SAIP). This was not only aimed at maintaining the delivery of our agreed targets, but will also complement the delivery of LAMP when we are able to proceed. It included:

> SAIP AD1/AD2/AD3: Changes to the Hurn sectors to reduce track mileage for Gatwick and Heathrow arrivals and the introduction of high level routes for Gatwick arrivals from the North;

> SAIP AD4: Widening of the Brest/Jersey interface at ORTAC; and

> SAIP AD5: Shawbury ATS routes across Shawbury triangle.

The new airspace will require a new concept of operations. We will work with the main TMA airports and peripheral airports in the south east, to deploy new SIDs, STARs, approach procedures and transitions to connect all in scope runways, including a third runway at Heathrow, to surrounding PBN routes. In general, this activity is from the surface to 7,000 feet. The full LAMP project (generally above 7,000 feet) will completely modernise the airspace through the implementation of closely spaced PBN routes. It will provide capacity and fuel efficiency benefits while facilitating the evolution of the controller task from relying on tactical intervention to planning and monitoring.

As a core part of the wider FASI-South strategy, we will continue to work closely with airport design teams to reduce noise impacts. This includes the innovative mathematical modelling of airspace design which supported both our consultation with the industry of initial design principles and a major framework briefing with the CAA. We have also engaged with and supported the airports through a revised TMA airports working group. This meant we could present a feasibility report to the Secretary of State for Transport in May 2018, preparing the way for completion of a feasibility assessment in November 2018.

As noted in the airspace risks section below, we have a significant external dependency on the airports' consultation and also the CAA and DfT. We will strive to nullify this risk through the co-ordination of major airspace change through the process described in Chapter 7. It requires support across the aviation industry to avoid this risk. The alternative option to deploying a network change above 7,000 feet would result in a sub-optimal design and would not address current capacity constraints for low level routes into and out of airports.

Outline benefits

The growth of air traffic in the TMA continues unabated. The development of a third runway at Heathrow is forecast to increase the demand at Heathrow from 480,000 movements to 740,000 movements a year, all to be delivered in a shorter operational day. This equates to a 50% increase in airspace demand in some sectors. The other TMA airports expect to be able to grow their businesses without any compromise or disruption caused by the Heathrow expansion. We aim to meet these demands through systemising the airspace and transitioning to a PBN approach that reduces the need for controller inputs.

Heathrow independent parallel approach

Working with the airport, we will introduce IPA at Heathrow to provide increased resilience and reduced holding. This will build on the current tactically enhanced arrival mode (TEAM). Much of the concept development for IPA has been undertaken during RP2 and we will deploy this capability during RP3, subject to the Heathrow-led airspace consultation currently planned to begin in 2019. This enhancement to operations will also be vital to three runway operations at Heathrow in RP4.

Outline benefits

The introduction of Heathrow IPA would increase the efficiency of TEAM operations, increasing the achievable landing rate and reducing holding delay during the periods when TEAM operations are in force. Current operations are constrained by the need to maintain diagonal separation between arrivals streams to the two runways, IPA allows independent operations.

Queue and capacity management

The Queue and Capacity Management Sub-Programme comprises three main elements:

> Airspace capacity management (ACM);

> Queue management, focusing on arrival management, and its links to departure management, which is an airport's responsibility; and

> TBS.

Airspace capacity management

During RP3, this capability will support improved and earlier planning. This will include a more efficient allocation of staff to meet an increasingly accurate demand prediction and assist with the forecast planning for ATCO numbers. Information will be shared with airspace users to improve collaborative decision making, which will be our preferred method of resolving demand/capacity imbalances. The ACM tool will also be developed ahead of deployment of systemised airspace to support demand/capacity balancing in a systemised lower airspace route network.

Outline benefits

> It will optimise the tactical traffic situation to meet ATC, airport and airspace user requirements. It will enable accurate allocation of controllers and airspace early enough to ensure that demand can be met where possible and will help to deliver opex efficiencies early in RP4 and beyond, assisting in the delivery of the one operation programme; and

> Systemised airspace demand/capacity balancing will support management of the new airspace structures, enabling the capacity increases associated with systemised airspace. We also expect it to support the resolution of problems, such as poor weather, which can affect the routes.

Queue management

European PCP regulations require implementation of extended arrival management procedures at Heathrow, Gatwick, Manchester and Stansted. During RP3, we will deploy AMAN at Stansted and will work with the airport to ensure arrival-departure management interoperability on its mixed mode runway.

We will also share the relevant arrival information with our upstream XMAN partners, ensuring that the European PCP requirement is met, as well as implement procedures to slow aircraft prior to descent when stack holding is predicted. A similar service is available to Manchester airport, although Manchester is responsible for the provision of approach services. We will ensure that Manchester AMAN information is supplied to our controllers in order to support descent speed procedures. This could also include XMAN partner ANSPs, subject to the method of AMAN implementation at Manchester.

For LAMP we will enhance AMAN in order to improve the streaming of aircraft into systemised PBN-defined arrival routes. Inbuilt functionality will calculate speed/time advice for controllers in adjacent ANSPs and will relay the information to pilots so they can adjust speed in the final cruise portion of their flight. The whole operation, and our customers, will benefit from a system that operates to plan and is able to minimise low level holding and share arrival timings with airports in advance.

Outline benefits

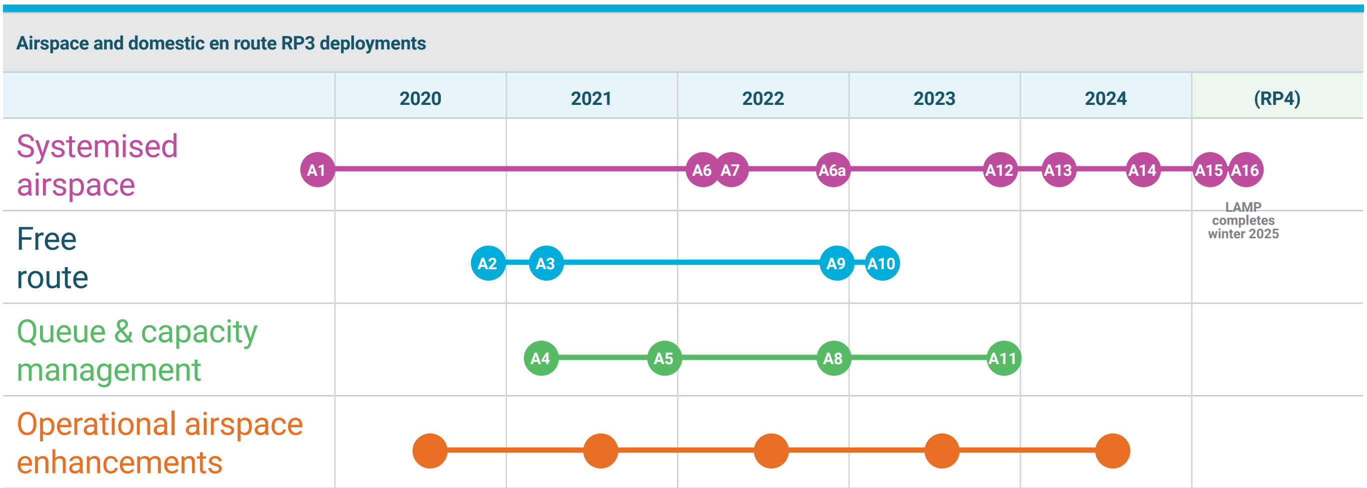
Introduction of similar tools at Heathrow have enabled fuel savings of 50kg per affected aircraft. The annualised totals will depend on the number of aircraft experiencing delay, but we anticipate that the implementation of systemised airspace will improve the fuel efficiency of descent profiles and should also reduce the total number of aircraft affected. It also meets the European PCP regulation for extended arrival management at Stansted. Pre-descent streaming will enable aircraft to use systemised descent PBN routes to a greater degree, enabling fuel efficient descent profiles.

Time based separation

TBS is already in operation on Heathrow's segregated arrivals runway. This will be enhanced during RP3 to use wake separation minima that is tailored to the individual pairs of aircraft types involved, a concept known as time based static pairwise separation. During RP3, TBS will also be deployed at Gatwick. This will require work to develop TBS so that it can operate on Gatwick's mixed mode runway, where arriving aircraft are often spaced to include a gap for one or more departing aircraft, and sometimes are separated by the wake vortex minima. There is a PCP requirement for Manchester to operate TBS by 1 January 2024. Airports are responsible for their respective approach services, which will, subject to agreement, require partial funding by them to achieve deployment.

Outline benefits

The introduction of Heathrow static pairwise TBS increases the landing rate, which either increases capacity or reduces stack holding and fuel burn, or a mix of these benefits. Gatwick mixed mode runway TBS also increases the landing rate, which increases capacity or reduces stack holding and fuel burn, or a mix of these. Finally, it meets a regulatory European PCP requirement for TBS introduction.



A: Airspace
1. PC lower airspace systemisation
2. PC free route airspace (selected sectors)
3. Initial dynamic sectorisation
4. AMAN expansion to Manchester
5. AMAN expansion to Stansted
6. Independent parallel approach (IPA)

6a. Heathrow IPA early morning

7. PLAS Manchester TMA
8. TBS Pairwise
9. Free route airspace (Swanwick and PC complete)
10. Advanced flexible use of airspace
11. TBS Gatwick (mixed mode)
12. LAMP enabling changes
13. LAMP (Phase 1)
14. LAMP (Phase 2)
15. LAMP (Phase 3)
16. LAMP (Heathrow R3 deployment)

Operational Airspace:
Localised benefit-led airspace enhancements delivered by domestic en route programme.

Airspace programme benefit information

	2020	2021	2022	2023	2024
Safety %	0	0*	1.3	0*	2
RP3 service secs/flight	**	0	0.2	0.8	6.9
Environment (fuel) kT p.a.	4.0	0.3	48	7	90

* Assumes mitigation of potential safety challenges through implementation of LAMP enabling changes.

** We anticipate that the availability of additional staff will generate an improvement in service at the start of RP3.

Airspace programme risks

There are a number of significant risks associated with this programme, particularly related to the delivery of LAMP:

> Major airspace change can only be delivered with the co-operation and support of government and airports. We have continued to create a political and economic argument that airspace is a national asset that must be developed in the interests of the whole economy.

– In mitigation, we work closely with the DfT and the CAA to ensure robust governance of the airspace modernisation so that there is commitment to system-wide change and it is deployed in a synchronised way. This may include technical, mandates and airspace change deployment mandates;

> This change not only includes a national airspace change but the co-operation of at least 15 airports, all of which need to consult and change their airspace and procedures in a synchronised way. There needs to be demonstrable commitment to modernisation by all dependent stakeholders, and a way of reporting progress that is monitored by the DfT.

– We are proposing to lead on the creation of a programme function to manage and co-ordinate the FASI-South airspace modernisation. See Chapter 7 for more details.

> There is an absolute dependency on the new technologies being delivered by the DSESAR programme. The inter-related nature of the portfolio requires the delivery of new technology ahead of the planned major airspace changes. Principally, this will enable airspace change on the new system, which has the capability to manage PBN techniques. It also simplifies and reduces the cost of delivery by implementing one system once, without having to deploy it on our current systems and then reworking it into new systems;

  – The portfolio has been developed with this key dependency in mind allowing much of the early development of LAMP to be achieved in parallel with the technology change and with close management of this dependency to deliver change at the lowest level of risk.

> LAMP development, transition and associated deployments are likely to present significant challenges through RP3, as we develop airspace change alongside technology change in our terminal operations.

  – We will continue to work closely with stakeholders as LAMP development progresses, with the emergence of designs, consultations, and as we develop a greater understanding of the consequence of deploying significant change into an already complex airspace infrastructure; and

> Training and transition phases of large change projects can impact service delivery performance for a defined period of time.

  – We will work with our customers to understand and minimise potential service impact throughout the deployment of technology and airspace change. We will seek the most efficient way to transition them into service, building on our recent experience of transition during ExCDS deployment.

Airspace programme capex (2017 prices)	2020 £m	2021 £m	2022 £m	2023 £m	2024 £m	RP3 £m
Free route airspace	9	9	7	1		26
Queue & capacity mgt	3	6	6	2	1	18
Systemised airspace	5	19	18	18	11	71
Total	**17**	**34**	**31**	**21**	**12**	**115**

Domestic en route operational service improvement

This programme provides investment to deliver small scale operational capability improvements (safety, capacity or environmental benefits) in support of wider airspace systemisation and DSESAR, and the agility to deliver rapid airspace change to address hot spots. Although this programme is mainly reactive, the nature of the requirements are well understood, and it has a high level of maturity. This gives us the opportunity to plan the programme with customers through the SIP consultations. It will be delivered through the two sub-programmes detailed below:

Swanwick Network Improvement Programme

The aim of the RP3 Swanwick Network Improvement Programme (SNIP) is to deliver small scale enhancements to Swanwick airspace. These enhancements aim to reduce controller workload and deliver increased capacity. SNIP will also exploit the opportunities created by the adoption of flexible use of airspace (FUA), which will deliver revised route structures that enable fuel savings for airspace users. These changes will be in addition to the larger airspace change programmes such as LAMP and the Swanwick FRA Programme. Traffic demand can fluctuate markedly from year to year for many reasons and the aim of this programme is to be able to react more quickly than is possible in the larger scale projects. We will be able to deliver smaller scale change to mitigate areas of network constraint between 2020 and 2024. We will not determine the areas to be targeted for improvement until approximately two years before deployment. The improvement will always be complimentary to future LAMP. Target areas may include:

> Delivery of modules that could not be delivered under the RP2 SAIP;

> Capacity enhancements on Swanwick Lakes and West sectors (Sectors 7 and 8) in response to the new Runway 28 North at Dublin;

> New routes to exploit increased airspace availability enabled by FUA;

> Airspace changes required to support LAMP and FRA and provide enhanced network connectivity; and

> Response to new airspace hot spots as they emerge, which without airspace improvement may require increased intervention to manage demand.

Prestwick Network Improvement Programme

Prestwick's RP3 Airspace Improvement Programme covers all of Prestwick's domestic airspace, working alongside SNIP and building on ATM system changes delivered under the DSESAR programme. Airspace efficiency and system capabilities go hand in hand, so the programme is being developed to make the airspace work for the system, and the system work for the airspace. This programme delivers changes to airspace design, utilisation and operation that proactively identifies performance improvements, and maximises the benefits delivered to key airspace users, including:

> Safety performance and safety risk reduction across Prestwick's operations;

> Airspace fuel efficiency, emissions and 3Di performance;

> ACM delays, measures and/or OPA identified hot spot areas; and

> Operational efficiency, ensuring that airspace and system sectorisation capabilities best match the operational demand with the available airspace and total ATM system capacity.

Operational system enhancements

The operational system enhancements element of this programme include funding to cover small scale changes that support localised airspace change or target performance improvements to safety, capacity, environment or efficiency. We typically identify these improvements from bottom up through operational reviews to pinpoint issues and opportunities. They can be delivered by small builds to individual systems. Funding covers changes to a range of key operational systems including iTEC and ExCDS as well as queue/flow management tools and safety nets.

Domestic En Route Programme benefit information

We will define the detail of this programme in response to specific short term requirements, and will only fully understand the benefits at that time. However, benefits are expected in the following areas:

	2020	2021	2022	2023	2024
Safety %*	1%	1%	1%	1%	1%
RP3 service secs/flight					3.5**

* Localised changes delivering linearly throughout the period totalling 5%.

** We expect realisation of benefit to be phased across the period once solutions are known.

Domestic En Route Programme risks

The risks associated with this programme will vary according to the issues that the programme addresses. We cannot quantify them at this point, but the principal risks are likely to be based on the following:

> Airspace change carries external risk associated with the need to engage with airports, the CAA and local communities. However, in the context of this programme the changes are typically smaller in nature than the main airspace programme, which can reduce the likelihood and impact of this risk; and

> System changes will almost always require some level of training and transition management to ensure a safe and orderly deployment. In the context of this programme the changes are typically small in nature and the scale of any training and transition activity is typically relatively low level.

Domestic En Route Programme capex (2017 prices)	2020 £m	2021 £m	2022 £m	2023 £m	2024 £m	RP3 £m
Operational airspace enhancements	2	2	2	1	1	9
Operational system enhancements	7	5	7	6	4	29
Total	**9**	**6**	**8**	**8**	**5**	**37**

Deploying SESAR

New technology was identified as a strategic response to meet the needs of customers and wider airline industry stakeholders. The DSESAR programme is our proposal to meet the majority of that response and, by extension, the requirements of our customers. It provides for a continuation of the programme begun in RP2 for the delivery of a modernised ATM system that will deliver a platform based service capable of handling large scale increases in traffic, enabling significant airspace transformation through FASI-South (LAMP).

The DSESAR programme will also enable the decommissioning of older technology to reach legacy escape and allows us to meet key regulatory PCP requirements published by the SESAR Joint Undertaking (SJU) in 2013. The SJU identified that the deployment of projects within the PCP had the potential to deliver a range of benefits including safety, capacity and productivity. The concepts were at different levels of maturity at the time of publication and as such not all are ready for full realisation during RP3. Uncertainty around this was confirmed in September 2018 by the EC Performance Review Body which noted that the SESAR deployment manager is re-analysing the costs and benefits of the PCP and SESAR projects to better understand their contribution to European ATM performance[7]. Our approach has been to include these elements within our programme and ensure we realise benefits as soon as the technologies and concepts reach sufficient maturity. The DSESAR programme is currently configured around three sub-programmes.

The rationale for this plan was set out during RP2 and supported by customers through the SIP 2017 consultation and subsequent publishing of the revised RP2 plan under Condition 10 of our Licence. It will enable us to deliver the benefits of a modern, flexible and agile platform earlier than originally expected, completing this journey by 2022 rather than 2025, and we intend to continue to implement it through to completion during RP3.

The switch from our current systems to the common DSESAR platform will bring significant benefits to our customers, in line with our understanding of customer priorities. These will be realised progressively as we move to the new systems, decommission our existing systems and introduce advanced capabilities that can take full advantage of the new technology.

We will deliver our service through a common platform that supports a range of advanced ATM tools. This will not only enable us to deliver the next phase of our LAMP programme, but will also remove the limitations on capacity that our current systems impose, releasing capability for future growth and maintaining safety.

The main components of the core plan for DSESAR are:

> Platform: A single common platform across our two centres enabling a common operation for all our domestic services that provides increased flexibility for normal and contingent operations;

> Trajectory services: Transition to new controller working position and flight data processing (FDP) capabilities, and the iTEC platform providing a modern solution capable of supporting new ATC concepts and modern airspace designs; and

> CNS services: Deployment of enhanced services to operate on the new platform providing increased resilience and flexibility with all services available at both centres.

The major milestones for DSESAR in RP3 are:

> DP En Route: The transition of our upper airspace to the new platform in 2020; and

> DP Lower: The transition of lower airspace in 2022.

Each of these milestones will provide increased resilience and flexibility to our operation, including the provision of initial trajectory based operations and new tools in upper airspace. The platform will also be the enabler for further operational improvements, notably by providing the infrastructure to support the implementation of FRA and LAMP during RP3. It will also provide the basis for further development in RP4, including enhanced dynamic sectorisation in upper airspace and advanced tools in lower airspace.

We will establish a dual running programme to ensure a safe and resilient transition to the new technology. This investment in people will provide us with the necessary support organisation for the DP En Route and the non-ATM development, training and pre-production services. It will enable a smooth and graceful switch from current systems to new technology delivered by the DSESAR programme. Much of the programme is well understood and therefore there is a high level of maturity to DP Lower; after which, our assessment is that the uncertainty in development has a lower level of maturity.

[7] PRB 2018 "PRB advice to the Commission in the setting of Union-wide performance targets for RP3", page 17.

DP En Route

This deployment point incorporates activity in the early part of RP3 to complete the delivery of DP En Route in the early part of 2020 and de-risk future transition steps ahead of legacy escape. It incorporates into one sub-programme two discrete areas that began in RP2, on which we have already reported:

> Area control voice communications; and

> En route area control and PC Upper iTEC and FourSight.

We plan to move area control and military into the combined operations room at Swanwick, supported by iTEC and FourSight. Prestwick upper airspace will move onto the latest version of iTEC with FourSight, common across both centres.

DP En Route will also be essential to reduce business risk of the on-going sustainment of legacy voice communications systems used by the Swanwick AC and military operations. These operations are currently run from the Swanwick temporary operations room. The harmonisation of the delivery of voice communications and en route area control resulted from our re-planning activity in early 2018. We became aware of a number of early warning alarms and risks, including:

> Possible delays to the core infrastructure from our supplier;

> Concerns with our voice system supplier to complete testing on the main voice system on time;

> Recommendations from the service design review;

> Lessons learnt from ExCDS; and

> The need to ensure adequate time is made available for our engineers to gain experience with the technology before going live.

Individually we could have accommodated these risks within the plan but, taken as a whole, we recognised that an early decision was required to address them in order to maintain the critical en route deployment date. We took the decision to act early and en route will be technically ready for operational use in April 2020, rather than the original March 2020 plan.

To mitigate the evolving risks, the plan incorporates a separate change to DP Voice by delivering it closer to DP En Route (from February 2019 to February 2020) without any negative consequence to the target benefits. The new voice system functionality is required for En Route as the existing platform can continue into 2020. We have sought to limit the rate and scale of change impact to operations, a considerable upside. This has been achieved through a significant reduction in the training required to switch to the new voice system so that it only forms a small part of the overall deployment training schedule in the revised plan.

En route area control and PC upper

The transition for area control and PC upper provides a 4D trajectory based FDP with the technology to support FRA and more flexible airspace designs in upper airspace. In addition, it provides improved resilience and contingency and the underlying capability to support new ATC concepts, for example, dynamic sectorisation. It removes key legacy assets from service and allows for resilience between both sites and prepares the way for the transformation of control in lower airspace. The majority of this work will be completed in RP2, with just the final stages of the deployment scheduled for completion in RP3.

In keeping with the lessons learnt from the ExCDS deployment in RP2 and subsequent customer approval, and our RP3 customer consultation, we have concluded that we will split the operational deployment of the iTEC FDP into two transitions. This will minimise the risk of disruption and maintain agreed service levels.

Prestwick will transition in April 2020 and Swanwick will follow on in November 2020. This roll out will not affect the dependent deployment path to DP Lower, other wider airspace deployments and does not impact on the delivery of the benefits we expect to deliver. In summary, this phased approach to deployment will enable a balanced and controlled transition to a modernised system for UK upper airspace with lower risk.

Voice communications

Area control will move over to a new VoIP communications system together with a higher performance backup system. This will reduce the risk associated with the existing voice system, which is end of life, will provide increased resilience to failure and will increase the flexibility of operations. This deployment will also de-risk future transition steps by gaining early experience of VoIP based communications, associated systems and supporting foundation services. This will represent the final stages of the deployment of the voice programme that is primarily delivered in RP2. These final aspects will support the roll out of the common VoIP solution to Prestwick.

DP Lower

Lower airspace: transition of selected lower airspace sectors to en route system

In order to gain the maximum benefit from the deployment of iTEC and FourSight in upper airspace we will move a small number of sectors from the lower airspace to the upper airspace groupings where this can add value. This will give these sectors access to the benefits of FourSight and simplify the subsequent transition of lower airspace to iTEC with ExCDS.

Lower airspace: transition TC and Prestwick centre lower airspace to iTEC and ExCDS

This transition provides a 4D trajectory based FDP with the technology to support systemised airspace and more flexible airspace designs. The iTEC FDP will be deployed to operate with the existing ExCDS paperless solution in both Swanwick terminal control and Prestwick lower airspace. The deployment of ExCDS during winter 2017-18 has already realised significant benefits, including a reduction in safety risk for both terminal control and area control, as well as a reduced requirement for operational support staff. Through this programme we will further reduce safety risk as we evolve ExCDS and maintain these capabilities as we introduce iTEC into terminal control. Use of ExCDS will simplify the technical solution at this stage and simplify the transition required for controllers. This capability will be sufficient to support subsequent deployment. In addition, this step provides improved resilience and contingency and the capability to support future ATC concepts, for example, dynamic sectorisation.

This is a key transition as it achieves legacy escape leading to a reduction in the number and cost of assets to sustain. We will ensure that current systems are run concurrently with the new platform to maintain a safe and resilient transition to the new technology.

RP4: terminal control and Prestwick lower iTEC and FourSight

The completion of the roll out of the DSESAR platform and transition to legacy escape in lower airspace will be completed with a technically lower risk iTEC with ExCDS solution. This is in keeping with our progressive approach to transformation to limit the extent of transition risk. However, we are aware that to maximise the benefits after delivery of the LAMP systemised airspace, as well as prepare for further evolution of the role of the controller supported by these tools, there will be a need to develop and implement FourSight tactical tools alongside iTEC.

Our recommended proposal is that this work should start in RP3 with the intent to deploy early in RP4. We are conscious that customers may wish to exercise choice and it would be possible to slow development in RP3, thereby delivering a reduction in capex in RP3. However, this would prevent implementation of the FourSight tactical tool in lower airspace until late in RP4. We would not recommend this approach unless traffic growth stalled or declined, as this would limit our ability to deliver the full range of benefits from the systemisation of lower airspace to our customers.

There are other potential ATCO productivity gains to be delivered in RP4. The SJU identified ambitious ATCO productivity gains of around 8% from flight information exchange (AF5) supporting SWIM and extended projected profile (AF6) supporting initial trajectory information sharing. These were not mature at time of writing and we continue to engage with the SDM to develop these concepts. We expect the level of maturity to have progressed sufficiently to enable a fuller deployment and realisation of benefits during RP4.

Outline benefits

We anticipate that there will be a number of significant benefits generated by the implementation of DSESAR technologies over the RP3 period. The most significant benefit of the implementation of DSESAR technologies will be the ability to handle safely the volume of traffic that we expect in RP3 and beyond. Additional benefits include capacity and environmental improvements which are reported in detail below as well as opportunities to increase productivity. As identified above, some of the PCP concepts were at different levels of maturity when published, and we will not be able to realise the full anticipated benefits of up to 12% productivity improvement during RP3 as a result. Based on a realistic assessment of ATCO productivity gains by employing new concepts based upon SJU PCP elements, we expect to achieve approximately 2% productivity from DSESAR during RP3. This will be realised through the introduction of initial dynamic sectorisation and improved sector team operations. It should be noted that we tend to use productivity to enable controllers to manage more traffic in the same timescale and airspace, enabling capacity growth to support increased traffic levels; an automatic ability to reduce controller numbers should not be assumed. The benefit of this improved productivity is managed as part of our overall approach to operational efficiency. See Appendix K for more details.

Turning to the outline benefits for DSESAR, the scale and attribution of these benefits is subject to further work and we will share it with customers as the programme matures. In the interim, the types and numbers of benefits likely to be generated by the DSESAR programme are:

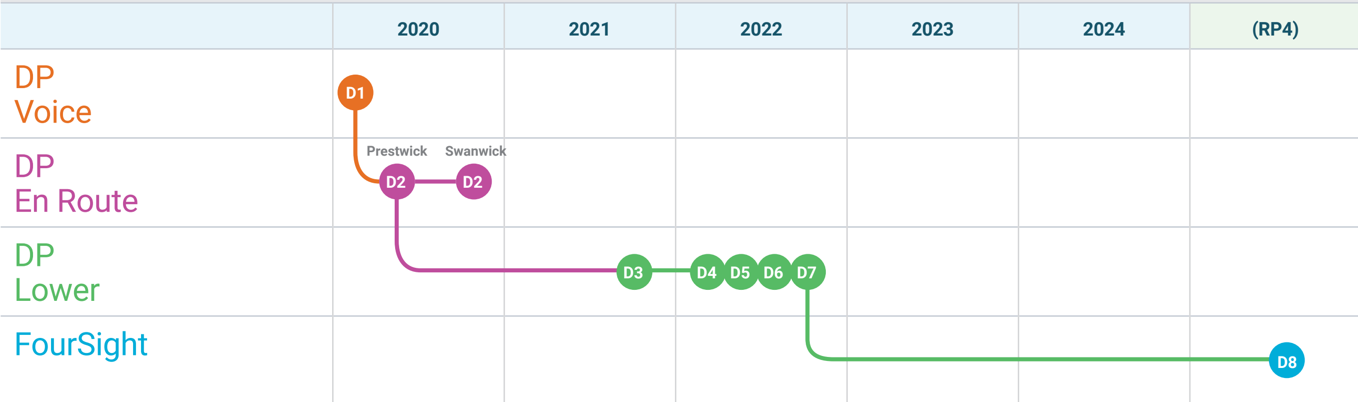
> Enabling the deployment of a common way of working for ATM will be the significant technological enabler for achieving the one operation vision for 2025. This will ensure on-going resilience and enable cost efficiencies by, for example, shortening initial training for ATCOs through the use of common tools and systems. The standardisation of modern equipment across units will also enhance the inherent safety of the operation. It will deliver service benefits through improved ACM and, in time, will generate cost efficiency benefits.

> Modern equipment, sourced mainly through commercial off-the-shelf, will enable speedier system change, greater reliability and agility through an increased level of competition. This approach will also increase the pace of our upgrade cycle and reduce cost through the availability of greater competition.

> Delivering new technologies such as iTEC (which replaces the current NAS FDP) and FourSight at DP En Route will strengthen safety, increase efficiency and improve the environmental impact of flights through advanced planning of flight trajectories. It will also improve interoperability with European centres and will integrate with SWIM, which is a regulatory PCP requirement. We expect significant benefits in safety, service, environment and cost-efficiency; and

> We expect the change from an asset based management to service oriented management to deliver improved cost efficiencies, as the platform based technology is designed to be supported through the ITIL based methodology which requires fewer highly specialised personnel to deliver. This is in keeping with the benefits delivered by operational transformation. In addition, we will make capability upgrades with greater speed while maintaining resilience. Finally, it removes a significant technical service risk as the DSESAR technologies replace our current systems which are becoming unsupportable.

DSESAR RP3 deployments



D: DSESAR
1. AC voice comms
2. iTEC & FourSight operational for en route
3. Selected PC lower sectors to en route system
4. Selected TC sectors to en route system
5. iTEC & ExCDS PCLA
6. iTEC & ExCDS TC
7. Common platform: legacy escape & mutual contingency
8. iTEC & FourSight operational lower airspace

It is important to recognise that DSESAR is a single programme that crosses the boundary between RP2 and RP3 and, as with any programme of this nature, does not have a natural break point between reference periods. We will continue to manage the programme as a coherent whole, which could lead to some adjustments to the exact delivery profile to ensure there is a smooth transition from RP2 to RP3 and that this boundary does not become a barrier to effective delivery.

DSESAR Programme benefit information

We have undertaken work to give an initial view of the benefits that will be delivered by the DSESAR Programme. This work will continue through the detailed planning process and into the early stages of the projects, as we develop a deeper understanding of how the programme will deliver, and push to increase the level of benefit that can be realised. The DSESAR Programme is expected to deliver the following confirmed benefits:

	2020	2021	2022	2023	2024
Safety %	0.2	0	3.5	0	0
RP3 service secs/flight				0.9	0.7
Environment (fuel) kT p.a.	5.8		1.9		
Technical service risk £m	31.9		39.8	13.1	2.8

DSESAR Programme risks

There are a number of risks associated with this programme:

> Legacy escape delay: There is a risk that additional time, funding and extended maintenance support would be required if there is a delay to the delivery of system solutions to replace ageing systems through the DSESAR programme. This would potentially lead to an increased requirement for investment or support funding.

– This risk is mitigated through the very close tracking and senior management oversight of the DSESAR programme.

> Supplier performance: Our dependency on the performance of suppliers, of which there is a limited range, rather than internal staff for the development of core systems could result in a risk of delay for the delivery of systems. This would lead to delays to the delivery of core systems and increased supplier costs.

– This risk is mitigated by intense collaboration with suppliers, including careful evaluation of tenders and the imposition of detailed contracts. Additional mitigation is provided by embedding of our staff and senior level weekly and monthly reviews of suppliers' progress.

DSESAR Programme capex (2017 prices)	2020 £m	2021 £m	2022 £m	2023 £m	2024 £m	RP3 £m
DP En Route	23	5	0	0	0	28
DP Lower: iTEC & ExCDS	94	80	16	1	0	192
RP4: iTEC & FourSight				17	63	80
Total	**117**	**85**	**16**	**18**	**64**	**299**

Technical resilience

This programme seeks to maintain sufficient investment to deliver a robust and resilient service, legislative compliance, operational performance and cyber resilience. We have a firm understanding of our assets and systems, and our planned changes have a high level of maturity. As we are part of the critical national infrastructure, we are aware that it is essential to have an appropriate and robust maintenance strategy. To that end, we adopt a risk based approach rather than a schedule based approach, as the risk of the consequence of failure far outweighs the cost of the equipment. We use this knowledge to ensure the right balance for cost and complexity of maintenance in the plan. We plan to deliver investment through two separate lines of development: centres and build sustainment and remote sites; and CNS.

Centres and builds sustainment

The objective of this sub-programme is to sustain current operational assets. Some will require support to the end of 2022, when they will be withdrawn from service at legacy escape. Others, including most of our outstation infrastructure assets will require on-going support to maintain resilience. This sub-programme also incorporates cyber security enhancements to protect our legacy assets from the growing threat. The significant elements of this sub-programme are listed below and account for the majority of the proposed sub-programme costs:

> NODE core: NODE is the surveillance tracker and safety nets used at Swanwick terminal control, Prestwick and Western Radar. Safety net components of NODE-L and the alert processor capability in the new en route centre (NERC) are obsolete, and failure to provide on-going support may result in the current safety net provision becoming compromised. This will result in an inability to maintain current risk index values as traffic levels recover and increase beyond previously experienced levels, which will become visible through increasing numbers of RAT points that are attributable to us. NODE will be retired at DP Lower by Tracksource1/Tracksource2/Safety Net Server and the Indra Workstation, but, with the current increase in traffic, NODE requires updating to meet traffic demand in the busy London TMA.

> EFD: This is the Frequentis flight strip product used in Prestwick lower airspace and the Manchester TMA. EFD went live in 2011/2012 and uses HP PC hardware and will be retired at DP Lower by iTEC. The system is starting to hit capacity problems now, with the total number of strips exceeding screen capacity in large sectors at peak times. We intend to refresh the servers and update the business rules to aid busy sectors.

> NAS: This is the main FDP system for Scottish lower and all of the London FIR. It also drives the large UK airports electronic flight progress systems. It runs on a mainframe computer and is mature software. NAS will be replaced at DP Lower by iTEC. This investment will provide minor enhancements to its performance to match traffic growth, and maintain a competent software team who will write the transition enabling changes for DP Lower.

> Aeronautical message switch (AMS) UK: This is the main message switch for all flight plan information in the UK and one of three main switches across Europe. All flight plans, flight plan amendments and pushback messages go through this system. This investment is required to port the AMS-UK onto the core strategic architecture, simplifying its future maintenance and development.

> Extended aeronautical messaging service (EAMS): This is a web based flight planning service. EAMS is internet-facing and therefore its security is of critical importance. We see significant probing of its firewalls and web pages on a daily basis. This investment will enable its re-hosting to reduce this risk.

> Cyber security: The risk in this area is significant and rising, and operating system upgrades, firewall enhancements/replacements and improvements to the security architecture of the current and future platforms are required.

> Minor sustainment: As already noted, risk of asset failure increases in line with the age of the systems. To avoid safety and/or delay impacts, minor sustainment activities across the current operational estate are required to manage systems to end of life. This will maintain resilience in the system. Within the RP3 timeframe there will also be some requirement for hardware refresh to the DSESAR platform that is currently being delivered (based on an average life of seven years for IT equipment).

> Simulations: The current simulator systems will require sustainment and continuing change to support staff deployment based on skills rather than location, until superseded by DSESAR during RP3. We will seek opportunities to consolidate equipment to reduce footprint, maintenance, CO_2 and to reduce opex costs associated with simulation creation and delivery.

> AIRAC Programme: This investment covers change that we are obliged to make to match changes by adjacent ANSPs, the MOD or that required by regulation, and minor changes to airspace that we choose to make to drive efficiency and safety in our operation.

Remote sites and CNS sustainment

The CNS assets require support across multiple regulatory periods. As the probability of failure increases with the age of the systems, we have planned annual sustainment and obsolescence management activities to manage the assets through to end of life, maintain resilience and deliver technical updates. The aim is to optimise technical resilience and sustainment expenditure and avoid the impact to safety and/or delay caused by service interruption.

> Navigation: We continue to work closely through RP2 with the CAA to reduce the number of doppler very high frequency omni-directional radio range (DVOR[8])from 47 to 19. Removal of the DVORs requires airspace change consultation and the programme hit significant delays due to airports referencing the en route systems in their SIDs and STARs. Some technical refresh of DVORs will be required within RP3 enforced by the elongated airspace change proposal timescales.

> DME rationalisation: Rationalisation of the distance measuring equipment (DME-DME[9]) triangulation coverage will continue through RP3 as the licence requirement for back-up to satellite navigation for commercial aviation. DME beacons are operating significantly past their end of life. Failure to replace them will result in the loss of DME navigation service in areas of airspace supporting key routes, significantly affecting aircraft operators, airlines, military flying, search and rescue, and GA. There could also be a potential increase in GA infringements of controlled airspace. Some airport operations, such as approach procedures, standard instrument departures and aircraft separation may also be affected. This will include investment in the technical refresh of the navaid remote indication control system and monitoring system for navigation aids.

[8] DVORs provide radio navigation to aircraft based on Doppler and radio-direction finding principles.
[9] Aircraft use DME to determine their distance from a land-based transponder thereby assisting in navigation.

- > Surveillance development: The 23 primary and secondary radars (PSR and SSR) in the field were fitted between 2007 and 2013 with a 15-year design life. This life was extended to 2027 for all sites in RP2 through a mid-life upgrade programme, and funding is required to sustain the current fleet and begin to replace it. This investment will continue into RP4, although we are assessing the scale of our future requirement and the technologies available to meet that requirement.

  The most significant future surveillance technology to date is ADS-B. We expect the requirement for PSR to remain into RP3 and beyond, as there is no realistic alternative for the provision of non-cooperative surveillance. It is possible that changes in airspace users and materials may even increase the requirement in RP4 for some higher fidelity short range PSR around airports. We will work to meet the CAA's intention to introduce electronic conspicuity to assess how we might develop and introduce technology, such as ADS-B, into our existing and future surveillance infrastructure. This includes the need to detect low power GA transponders to provide wider electronic conspicuity and improve resilience and capability for our surveillance infrastructure.

  The management and integration of drones into our surveillance systems is considered in more depth in the wider plan (Chapter 7). This will ensure that the surveillance service is suitably flexible and resilient to support the changes to traffic and users expected in RP3 and the future.

- > En route radar control and monitoring system: The control and monitoring system for radars is over 15 years old and relies on a number of bespoke sensing capabilities. Careful management of the system has elongated its life but issues with spares availability and software supportability has meant that replacement is now scheduled for RP3.

Outline benefits

There are a number of significant benefits generated by this detailed programme. The principal benefit is the reduction in technical service risk to the operation. The delivery of a reliable and resilient service requires on-going investment to maintain performance. Our outputs require a significant investment in specialist technologies, although the programme is designed to support the implementation of DSESAR technologies over the RP3 period and its benefits. Notwithstanding DSESAR, there will remain a considerable level of investment required in RP3 and beyond to maintain the CNS infrastructure into the future.

Technical Resilience Programme benefit information

The Technical Resilience Programme is expected to deliver the following benefit:

	2020	2021	2022	2023	2024
Technical service risk £m	0.6	0	8.6	0	8.9

Technical Resilience Programme risks

There are a number of risks associated with this programme:

- > Logistics and weather pose a risk to timely completion of works for CNS and centres, resulting in potential cost overruns and/or impacts on dependent systems. Adverse weather conditions may result in rescheduling and there are two further challenges: the rate of traffic and demand for systems can prevent the release of chilled water systems in the summer months; and cold weather conditions can prevent access to remote sites.
- > The ability to source skills and equipment for older equipment poses an obsolescence risk at some of our sites.
  - – We aim to mitigate this by careful asset management in conjunction with close collaboration with our supply chain team to maintain availability of alternative sources of supply.

Technical resilience programme capex (2017 prices)	2020 £m	2021 £m	2022 £m	2023 £m	2024 £m	RP3 £m
Centres & builds sustainment	13	12	21	19	14	79
Remote sites & CNS sustainment	13	15	14	12	12	66
Total	**25**	**27**	**35**	**31**	**26**	**144**

Business resilience

We will ensure the availability of safe and secure information services and an estate that supports a safe operation. The programme supports this through two lines of development, facilities management (FM) and information solutions (IS). Facilities management includes property services, building and engineering services, environment (we have committed to reducing the technical load of estate CO_2 emissions by 2024 by 30%) and health and safety.

Information solutions is an essential component of business resilience. The increase in the cyber threat to the business, reflected in revised legislation, requires the implementation of upgrades and new services to meet the needs of the business moving forward. We have a firm understanding of our assets and systems, and our planned changes have a high level of maturity.

This programme provides sustainment of the business systems across the following areas.

Facilities management

We have 177 freehold and leasehold sites across the UK with an insured value of approximately £410m for the buildings alone. We have taken a limited approach to investment in this programme, which will satisfy the minimum required to meet landlord obligations, health and safety legislation. It will also mitigate noteworthy risk against Swanwick and Prestwick, which are part of critical national infrastructure. The proposed plan also recognises that expenditure was limited in RP2 and that there is now a requirement to meet these needs urgently. Specific areas for focus will include:

> Ensuring a resilient on-going service at Swanwick and Prestwick through upgrade/replacement of building management systems and uninterruptable power supplies. Obsolete and ageing equipment places an increased risk of an unplanned loss of FM services so we have planned investment to improve resilience;

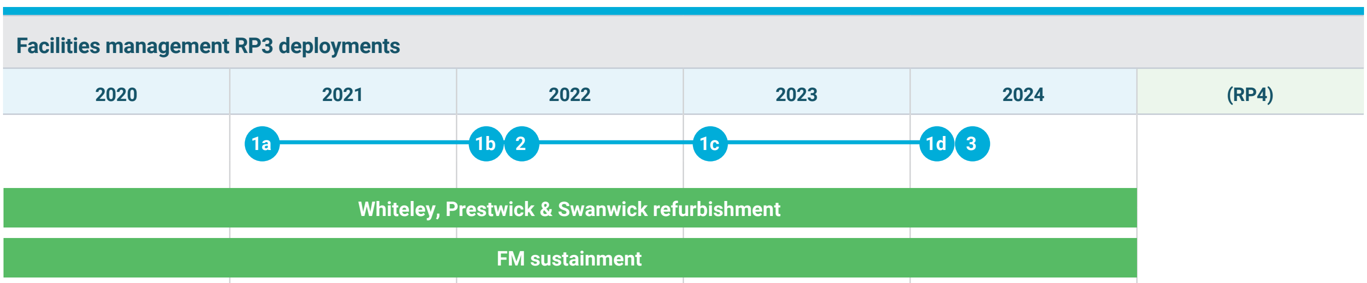
> Ensuring on-going compliance with fuel oil storage regulations, the condition of the fuel storage and delivery systems at certain CNS sites requires regular assessment and investment to avoid a major fuel leak. A leak would lead to the need for remediation to clean up the site and affected ground, and immediate investment in new facilities;

> The increase in the threat of politically motivated hostile activity has led to the need to deliver enhancements to physical security measures, staffing and procedures to avoid injuries, fatalities and/or damage or loss of services at our centres; and

> Required on-going support of the radome and planned replacements to avoid the risk of further catastrophic failures. This is evidenced by the Lowther radome failure. Catastrophic loss of a radome would impact the availability of the radar service at the site without warning. Depending on the damage and the availability of spares, the consequence could be that the affected radar remains unavailable for a prolonged period (12 months). This could result in us being unable to provide a service in the region, or having to consider flow control measures due to concerns about the availability of the remaining service. Regular surveys continue to support a programme of replacement through the regulatory period.

Outline benefits

> The most significant benefits are a reduction in technical service risk (the target is to ensure no FM attributable delay or safety incidents) and contributions to our environmental target of a 30% reduction in carbon emissions (of the technical load). In addition, it ensures we deliver a compliance benefit by providing a safe operational environment. We will also be able to realise cost efficiency benefits through opex savings by ensuring and influencing infrastructure projects.



1. CNS replacement of expired systems/facilities (radomes, generator, UPS)
2. Swanwick UPS replacement
3. Prestwick obsolete system replacements (UPS, electrical, fire & building)

Information solutions

There is a need for sufficient performance, capacity and security of our information systems in order to ensure they can continue to support our business processes. To do this we must maintain the performance, capacity and security of our IT components. This ensures that they will continue to provide the storage, transmission and compute services which underpin the intra and inter-business collaboration necessary for us to succeed. Our business IT systems directly support a user population of around 3,500 staff and contractors who undertake collaborative working and content/data manipulation via a range of endpoint devices and connection modes across three main UK sites. It is essential to maintain this diversity of connectivity and usage as an efficient, safe and secure environment in order to meet the needs of our customers and avoid damaging security or data related incidents. We aim to reduce the risks to our business posed by those who may try to exploit known and emerging security vulnerabilities by ensuring that our systems and software are kept in line with manufacturer's recommendations and that our networks are appropriately segmented.

Our strategy is to provide flexible and responsive IT services which leverage the most cost effective mix of cloud based and on-premise platforms and services. The key areas of work in this sub-programme will be:

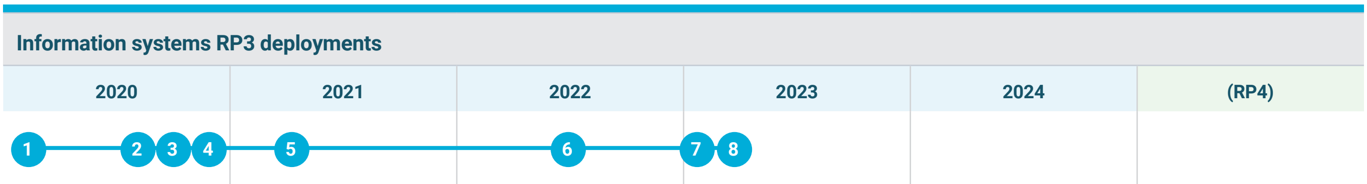
> Core infrastructure sustainment in order to maintain the performance, reliability, and capacity of the existing IT infrastructure (hardware and software for networks, compute, storage and telephony) and to add infrastructure components to support new applications;

> Applications and data visualisation that maintain the performance and regulatory compliance of business IT systems; and

> Enhancement of security and cyber resilience to reduce the likelihood of unauthorised access to our data from internal and external attack.

Outline benefits

> The key benefits are a reduction in technical service risk and compliance with a range of UK law including the Computer Misuse Act, Network and Information Security Directive, and general data protection regulation.



1. Microsoft licence renewal.
2. Business intelligence upgrade.
3. Replacement of obsolete core network components.
4. Provide managed application development toolkit.
5. Migration of content to upgrade collaboration space.
6. ERP SW platform upgrade.
7. Remediation of business applications support issues.
8. Microsoft licence renewal.

Business Resilience Programme benefit information

The Business Resilience Programme is expected to deliver the following reduction in risk.

	2020	2021	2022	2023	2024
Technical service risk £m	9.3	8.8	10.2	8.8	8.8

Business Resilience Programme risks

There are a number of risks associated with this programme:

> CNS and centres: As with the technical resilience, programme logistics and weather pose a risk to timely completion of works which could result in potential cost overruns and/or impacts on dependent systems. Adverse weather conditions may result in re-scheduling. Two further challenges are: the rate of traffic and demand for systems which can prevent the release of chilled water systems in the summer months; and cold weather conditions that can prevent access to remote sites.

> The ability to source skills and equipment for older equipment poses an obsolescence risk at some of our sites.

– We aim to mitigate this by careful asset management, in conjunction with close collaboration with our supply chain team to maintain availability of alternative sources of supply.

Business Resilience Programme capex (2017 prices)	**2020 £m**	**2021 £m**	**2022 £m**	**2023 £m**	**2024 £m**	**RP3 £m**
FM	11	11	10	10	9	52
IS	11	7	7	6	4	36
Total	**22**	**18**	**17**	**17**	**13**	**88**

Oceanic[10]

In line with the modernisation and systemisation of en route and lower airspace, this programme seeks to emulate that progress through the deployment of reduced separation standard minima, the progressive de-structuring of airspace and the removal of airline constraints. We aim to achieve this through the implementation of ADS-B surveillance supported techniques that enable reductions in separation, allow the introduction of variable mach operations and introduce user preferred trajectories in high level airspace. These changes, in conjunction with a traffic and workload management capability in oceanic airspace, will improve the efficiency of oceanic airspace. The key components of this programme include:

> Reduced separation standards/variable mach: These will leverage the capability within space based ADS-B to enable customers to fly the trajectories they require. It will require sustainment of performance based communication and surveillance (PBCS) standards to provide service resilience in the event of ADS-B fall-back operations;

> Traffic complexity management: It is necessary that we improve the airspace capacity management in the oceanic airspace. There are options to leverage the solution generated through DSESAR or to align with the Gander automated air traffic system plus (GAATS+[11]) system sharing development with NAV CANADA;

> Reduced conflict horizon: Current planning requires a volume of airspace to be sterilised when projecting each flight trajectory. This will reduce the window from its current four to five hour duration to one of less than an hour. No benefits are claimed within the plan at this stage; and

> Oceanic sustainment: We continue to collaborate with NAV CANADA on the Oceanic Airspace, Systems and Tools Programme of joint oceanic ATM system development and require system sustainment to match high case traffic growth/service complexity. The oceanic ATM system is not required to achieve DSESAR architecture compliance in RP3, though data link performance and capability must meet the levels necessary to support/sustain the application of advanced surveillance enabled procedural separations and PBCS separation standards.

Outline benefits

The significant benefits for customers will accrue from the enhanced ability to fly the profile that they wish to fly. Reduced separation and variable mach will deliver environmental benefits through fuel savings and cost efficiency for airlines.

Oceanic Programme benefit information

The Oceanic Programme is expected to deliver the following benefits:

	2020	2021	2022	2023	2024
Safety %	Reduce vertical collision risk				
Environment (fuel) kT p.a.	80	1	27	27.5	2
Technical service risk £m	0.2				

Oceanic Programme risks

There are a number of risks associated with this programme:

> That the assets needed to deploy key deliverables of this plan, in particular the ATM system and ATS surveillance, are not available in time.

– We will mitigate this risk by ensuring that we have a development, assurance and deployment plan aligned with the suppliers of the ATM system and ADS-B, and that this is protected by appropriate contractual arrangements.

> That the full realisation of the benefits of ADS-B if deployment and capacity is not aligned with deployments being made in adjacent airspace.

– This is mitigated through a close working relationship with other oceanic ANSPs, and joint development and deployment of service improvements.

Oceanic Programme capex (2017 prices)	**2020 £m**	**2021 £m**	**2022 £m**	**2023 £m**	**2024 £m**	**RP3 £m**
Oceanic	4	2	5	1	3	15
Total	**4**	**2**	**5**	**1**	**3**	**15**

[10] This section provides a high level overview of the oceanic investment programme for completeness. A fuller description of the plans for the oceanic service line, including planned investment is provided in Chapter 8 and Appendix M.
[11] GAATS+ is an air traffic management system for use in the North Atlantic.

In addition to the capital investment programmes noted above, two other programmes will be crucial to realising benefits across the portfolio. These are as follows.

Service orientation

This programme sets out our plan to modernise our engineering capability to align with the new service orientated architecture and to take advantage of best industry practice. The programme will enable us to adopt service-led principles and exploit the new service operations management (SOM) tools. These tools will be more effective and improve the quality of customer service through closer linkage with operational services, and deliver benefits to our customers downstream.

Service management will be based on ITIL, which provides an industry standard framework for managing services. The transition to a service oriented architecture on the DSESAR platform gives us the opportunity to switch to a service oriented approach, based on the proven ITIL service model. This is a new approach for the ATM industry, but it is a common approach in many service industries.

This programme will be enabled by the implementation of the SOM via the platform programme and a service transformation people plan. The integration of both elements will ensure that the organisation is ready to manage and operate the new services deployed under DSESAR, and will establish the necessary capabilities across people, process and technology. This will pursue a variety of workstreams to enable the shift to an as-a-service delivery model and embed the new ways of working for service management and service integration. These will include:

> Organisational design;

> Operating practices and procedures;

> Competency, including air traffic safety electronics personnel;

> Training;

> Assurance;

> Continual service improvement;

> Rostering; and

> Business processes.

Outline benefits

This work is led by a single unified team with director level sponsorship. It will be managed under portfolio governance to ensure that the required outcomes are delivered alongside the delivery of the technology transformation. Our new service's flexibility and robust design will provide increasing resilience, thereby reducing technical service risk over time. The ability to be proactive in our management and deployment of resources will also enable us to deliver cost efficiency benefits once the modernised ATM service enabled by DSESAR is in place.

Outline risks

There is a risk that the process and cultural change required to modernise our engineering capability cannot be delivered because of the dependency on the technology programme to deliver high levels of automation, which may not be met.

Operations integration

In order to realise the benefits from the common platform and airspace modernisation, there are a number of significant changes that need to be delivered in the operational environment to reach the One Operation – Two Centres vision. The majority of cost is likely to be incurred as revenue costs, as much of this change programme will be delivered through changes to operational procedures and practices. This is also likely to entail organisational alignment and revised workforce planning that provides more flexible resource. This will mean that we will be less constrained in its deployment than now and will be able to safely match it to customer demand.

One Operation 2025 represents our vision for the future operation. Along with new technologies, it reflects the adoption of a unified operating model, with standardised processes and joined up, flexible ways of working across the operation. The key changes that are associated with this programme are:

> Safety: There is a need for safety programmes to raise awareness and capability which, through enhanced safety data, will allow leaders to make risk based decisions. Safety teams and data will be centralised and approaches will be standardised. Principles for the implementation and use of automation by controllers will be embedded in the change programme.

> Business processes: It will contribute to the refreshing of our management system, based on the principles of service management. Processes and roles will be standardised based on the various functions that exist across our organisation.

> Rostering and resourcing: A single rostering and resourcing service will support the whole operation and resourcing tools will assure mid-term resourcing requirements based on available data. Systems will provide post-operational analysis of the planned and actual utilisation, in addition to providing visibility of future resource constraints. The central resourcing team will not use operational staff for roster creation.

> Competency and licensing: A single competency scheme will measure ATCO and on-job training instructor competence, which will support the proficiency of operational supervisory staff. Support roles that do not require a license will be reviewed by standard performance management processes.

> Support staff: A single operational support service will provide efficient and high quality customer services to any location, either physically or virtually. The service will include ATSA positions in both operational centres. The support team will be developed to be multi-skilled and agile, with more rewarding roles and a simple structure. This will provide greater flexibility, allowing the team to work alongside automation and absorb new services with minimal role redundancy or impact on headcount.

> Training: All initial training will be conducted on the same tools and systems that we use in the live operation and end-to-end training time (to validation) will be reduced progressively to 18-24 months. There will be a flexible approach to the delivery of rating training, allowing choice in the type of airspace used to deliver the training.

> Workforce planning: We will have a single, unified process for workforce planning across the operation. Clearly defined interfaces between operations and technical services will manage supply and demand, ensuring improved data integrity and consistency.

Outline benefits

This work will enable our operation to begin to capitalise on the modernised ATM service enabled by the DSESAR and airspace programmes. The extent of benefit will be delivered through increased levels of safety through optimised training and the availability to controllers of high-fidelity tools. There will need to be a shift in culture to adapt to greater reliance on PBN techniques, but this in turn will enable us to maintain the level of service and begin to deliver cost efficiencies in the longer term. There is a technical risk that will be mitigated through the adoption of greater flexibility between the two key centres. These benefits and attribution are subject to further work.

Outline risks

There is a limited risk that the process and cultural change envisaged in this programme is not supported by the workforce so that it creates a loss of momentum and a failure to capitalise on this change opportunity.

This risk will be mitigated through careful engagement with our people, and clear, consistent leadership across the business.

Enhanced SIP process proposed

As mentioned in Chapter 9, we discussed with our customers during the RP3 customer consultation process enhancements to the SIP process for RP3. These are described below:

> Agreeing key level zero milestones or other milestones with customers at the annual full SIP meeting, which will be tracked[12] under the SIP process;

> After we have agreed them, we will track the milestones and if there are changes will use the following principles to engage further with customers;

– Safety: If an immediate change is required, we would advise customers and the CAA;

– Small: If there is a change to the implementation plan which does not affect key milestones, we would provide an update at the next SIP;

– Medium: If there is a change to key milestones incorporating either a 10% cost increase which cannot be saved across the remaining portfolio, or three months change to a key milestone or a 10% change to benefits (scale or timescale), we would update at an ad-hoc meeting/WebEx to seek customer feedback on options. Note: there may need to be a quick turnaround from customers to avoid delaying the programme; and

– Large: If there is a material and fundamental change to key milestones/projects, or where projects are stopped, or significantly changed in scope/benefits/delivery or external factors are inhibiting delivery, then we would hold a face-to-face update with customers with a formal options review before making a decision. Any proposed re-purposing of investment funds would be included in options review before any decisions. This would be via an ad hoc meeting not just through the SIP cycle. An escalation process is also proposed.

[12] Note: Does not remove requirement for overall SIP reporting of total Capex plan.

Appendix M: Our oceanic plan

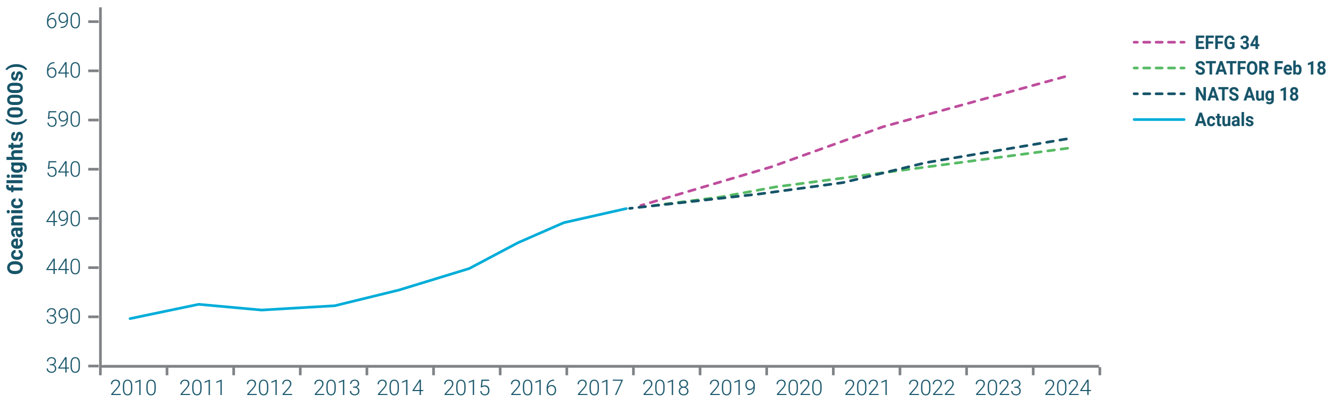
As described in Chapter 8 of our plan, the introduction of satellite based surveillance will transform the oceanic service. It will significantly improve safety. It will allow our customers to plan aircraft routes and trajectories at shorter notice and enable aircraft to fly closer to one another, using more efficient routes and more optimal flight levels and speeds.

This change will bring significant fuel savings, as well as providing the level of service that our customers require during a period of significant and sustained traffic growth. Crucially, it will also enable the oceanic service to meet the International Civil Aviation Organisation (ICAO) target for the level of safety across the North Atlantic, something that is not possible using existing technology. This appendix provides further information regarding our traffic forecast, the costs and benefits of our RP3 plan, and additional detail in relation to our prices and proposed basis of charging.

Traffic forecast

The chart below shows the forecast growth in oceanic flights that we project for the RP3 period. Our August 2018 forecast is shown in dark blue. We forecast that there will be nearly 570,000 annual oceanic flights by the end of RP3. This is an increase of 14% compared to 2017. This builds on growth which averaged around 6% p.a. between 2014 (end of RP1) and 2017.

Oceanic flights forecast



The table below breaks down our August 2018 traffic forecast for RP3 between Tango and North Atlantic flights.

NATS August 2018 oceanic traffic forecast

Oceanic flights '000	2020 plan	2021 plan	2022 plan	2023 plan	2024 plan
Flights: Tango routes	38	39	41	43	44
Flights: North Atlantic	486	494	505	516	525
Total oceanic flights	**524**	**533**	**546**	**559**	**569**

- Tango flights reflect traffic operating on the Tango routes (T9, T16 and T213), plus any flights that are not on one of these routes, but which either enter the south east corner airspace from the south and exit in the north, or enter this airspace from the north and exit in the south.
- North Atlantic flights mainly reflect the core east-west flow of traffic but also include flights which travel across the south east corner but not in a north-south direction, or on a Tango route. For example, flights which enter the south east corner from the north and exit the south east corner to the west.

Our August 2018 traffic forecast for Shanwick is based on a combination of forecast methods. The transatlantic arrival and departure flows to and from the UK are forecast from passenger demand using the same methodology as the UK flight information region (FIR) forecast. The Shanwick traffic flows which overfly the UK FIR are forecast using trend analysis from historical data, and the Shanwick traffic that does not enter the UK FIR is forecast using the STATFOR[1] growth rates. Our forecast has more detail, which allows chargeable service units (CSU) and various other data to be extracted, for example the south east corner.

STATFOR does not produce a dedicated oceanic forecast, instead we derive our forecast from the STATFOR Europe to North America forecast, so it excludes flights that do not enter Europe. The traffic forecast produced by ICAO's North Atlantic Economic, Financial and Forecast Group (EFFG) is also shown on the chart on the previous page as the purple dotted line. This forecast was introduced in 2016. It is derived from published fleet expansion plans for Airbus and Boeing to the end of 2022 and reflects peak week growth (15 - 21 July) rather than for the entire year, with a focus on US airlines rather than all NAT operators. Forecasts beyond 2022 are based on median projections from other forecasts, such as passenger traffic growth rate forecasts - International Air Transport Association, Boeing and Airbus - to create this traffic forecast.

Our traffic forecast for RP3 shows lower levels of growth than the NAT EFFG forecast for the same period. We are confident that it is appropriate to use our August 2018 forecast in creating the oceanic plan for RP3 because:

- The methodology is consistent with our forecast for the UK FIR for en route;
- It allows us to extract data for the south east corner on a consistent basis;
- The values are closely aligned to the level of oceanic traffic in the latest STATFOR derived traffic forecast (Feb-18), shown in the chart as the orange dotted line; and
- The EFFG forecast for the North Atlantic has only recently been established (in 2016). There is limited data available to evaluate the historical accuracy of this forecast, the methodology it uses, and the appropriateness of using this forecast for oceanic traffic.

Collaboration

In order to deliver our plan, we will collaborate with, and need the engagement and support of, a wide range of stakeholders, including:

- The Irish Aviation Authority (IAA);
- The UK and Irish governments;
- North Atlantic Systems Planning Group (NATSPG), its working structure, partners and the wider ICAO structure;
- Neighbouring air navigation service providers (ANSP) and network managers;
- Our customers through: NAT service groups; our performance, flight efficiency and safety improvement groups, and directly on routine areas of mutual interest and customer need; and
- Our suppliers, service partners and other stakeholders, such as flight planning providers and communication service providers, to enable the development of the infrastructure beyond our control.

Cost efficiency

A breakdown of our projection for the oceanic determined cost base during RP2 and RP3 is set out in the table on the next page. This distinguishes between core oceanic costs, which relate largely to the same scope as today, and the necessary satellite data costs - third party costs that will be incurred from the start of RP3. Satellite data costs will be split between those incurred specifically for the Tango routes (south east corner) and those that are required for the wider North Atlantic (NAT crossing) service.

[1] Statistics and forecast service of the Eurocontrol Agency.

Oceanic determined costs in RP2 and RP3

Oceanic determined cost £m	RP2	RP3
2017 CPI prices (calendar year)	Avg	Avg
Efficient operating costs	15.8	17.6
Cash pension costs	3.4	3.5
Depreciation of the RAB	4.8	5.9
Regulatory return (inc. tax charges)	2.3	2.1
Other revenues	-0.5	-0.6
Core oceanic costs	**25.8**	**28.6**
Satellite data charges: Tango	0.0	0.1
Satellite data charges: North Atlantic	0.0	15.8
Total oceanic costs	**25.8**	**44.5**

Oceanic charges (£ / flight)	RP2	RP3	Diff
2017 CPI prices (calendar year)	Avg	Avg	Avg
Core oceanic price	59.99	52.36	-13%
Satellite data charges: Tango	0.00	3.65	n/a
Satellite data charges: North Atlantic	0.00	31.29	n/a

Cash pension costs and depreciation of the regulatory asset base (RAB) in RP2 reflect the fixed allowances set by the CAA. This follows the treatment of these items within the regulatory accounts and is consistent information presented for our en route service.

Core oceanic costs

Excluding satellite data charges, the costs of the oceanic business are projected to increase from £25.8m to £28.6m p.a. (2017 prices). This £2.8m p.a. increase includes:

> £1m p.a. relating to an increase in oceanic air traffic control officers (ATCO) from around 45 full time equivalent (FTE) at present, to 55 FTE by 2024, to handle additional traffic;

> £1.9m p.a. relating to the recovery of oceanic investments made during RP2 (Stamper and Telstar), plus the rate of regulatory return on these investments; and

> Other movements, which reduce cost by £0.1m, mainly due to a lower cost of capital, partially offset by a small increase in cash pension costs.

Satellite data costs

Our planned introduction in 2019 of air traffic service (ATS) surveillance in oceanic airspace will be through a managed service from Aireon, a global provider of ADS-B[2] data services. Our service agreement with Aireon:

> Secures access to ATS surveillance data within oceanic airspace from 2019 until 2030;

> Is subject to safety and economic regulatory approval during each reference period;

> Provides access to independent airspace service volumes i.e. south east corner and core NAT airspace, with clear criteria for activating data services and charges; and

> Provides for use during trials, limited operational service, and for permanent operations.

Aireon data services are charged in accordance with airspace service volumes, providing:

> A firm fixed annual fee for south east corner airspace;

> A firm fixed annual fee for core NAT services[3]; and

> A firm fixed annual fee for maintenance and managed service fees.

[2] Automatic dependent surveillance - broadcast.
[3] Firm, fixed pricing for core NAT services is subject to further final work between NERL and our supplier.

The table below provides the breakdown of the illustrative Aireon data charges for the RP3 period. This uses an exchange rate of £1 = US$1.30 and values are shown in 2017 prices.

Oceanic determined cost					
2017 CPI prices (calendar year) £m	2020 plan	2021 plan	2022 plan	2023 plan	2024 plan
Satellite data charges: Tango routes	0.1	0.1	0.1	0.1	0.1
Satelite data charges: North Atlantic	15.2	15.5	15.8	16.1	16.4
Total satellite data charges	**15.4**	**15.6**	**16.0**	**16.3**	**16.6**

Totals may not add, due to roundings

Capital expenditure

The table below provides greater detail relating to oceanic-specific capital investments and associated benefits. These investments are essential to achieve the benefits from the introduction of satellite based surveillance.

Outcome / milestone description	Capex	Target date	Benefits
Safety improvement and introduction of reduced longitudinal and lateral separation standards	£4m	2020	Introducing ADS-B at this stage brings safety improvement benefits through faster flight profile compliance monitoring and intervention. Delivers c.85kg per flight airline fuel burn reduction, plus a further c.84kg fuel uplift through increased predictability of operations. This reflects ADS-B advanced surveillance enabled procedural separations (ASEPS) deployment, with performance based communication and separation (PBCS) standards available to provide service resilience in the event of ADS-B fall back operations.
Removal of mandatory speed control			Delivers a c.237kg per flight airline fuel burn reduction through deployment of cost index/variable mach operations to enable flexible speed use.
Deployment of an aligned UPR CONOPs across the NAT	£2m	2021	Delivers a saving of 122kg, rising to 243kg per flight between 2021 and 2022 by improving the horizontal efficiency for airline operations.
Deployment of traffic/complexity management capability	£5m	2022	Enables shorter flight times of up to 2.4 minutes per flight; enables the avoidance of service delays when workload peaks occur and/or further increases to ATCO numbers; enables the implementation of tactical clearance with reduced conflict horizons. The increased complexity of oceanic services requires a solution that is consistent with our DSESAR capabilities. This will assure service efficiency and successfully avoid safety events (i.e. overloads) through better matching of operational staff to the sectorisation needed to meet service demands.
Infrastructure/ATM system refresh	£1m	2022	Delivers ATM system sustainment, resilience and infrastructure interoperability.
Introduction of reduced conflict horizon/tactical clearance capability	£3m	2024	Delivers flight efficiency benefits through greater access to more cost effective flight trajectories, through the reduction in the volume of airspace protecting each flight trajectory. This is expected to reduce the window from the current four to five-hour duration to c. 45 to 60 minutes.
Total	£15m		

Oceanic prices

Basis of charging

Our business plan is presented using the same basis of charging that currently exists – a charge per flight, which does not vary by aircraft type, weight or distance flown within oceanic airspace. We consider that this continues to be a credible option that is a cost reflective basis of charging, and one that fairly recognises the shared/common costs incurred by core oceanic services and the variation in costs that we will incur in relation to satellite data for the Tango and wider North Atlantic airspace.

We discussed alternative approaches to charging with airlines during our RP3 customer consultation. They did not support a weight and distance based charge, similar to the Eurocontrol formula (CSU based), nor did they want to move to distance based charge (excluding the weight dimension from the CSU formula).

The need to move away from CPI-X pricing

Oceanic prices are currently calculated following a CPI-X[4] model. For RP3, we are proposing to calculate oceanic prices by simply dividing our projection of oceanic costs by forecast traffic volumes in each year, in a manner that is similar to domestic pricing arrangements, rather than using a uniform CPI-X methodology. This is due to the size of Aireon's charges relative to the rest of the oceanic business, and the potentially uneven profile of these charges across the five years of the RP3 period. Our proposed approach would better reflect the cost of the services that we will provide in each year.

This proposed change means that we will need to deal with inflation in a manner that is consistent with domestic arrangements. We will calculate oceanic prices for each year based on forecast consumer price index (CPI), but we will make an adjustment for actual inflation on an n+2 basis. This inflation adjustment will also cover satellite data charges.

This proposal is based on a working assumption that the Aireon costs we incur will also be linked to CPI or an index that closely follows CPI. If this is not the case, we will need to consider whether other mechanisms are required to avoid inflation related gains or losses for our customers in relation to satellite data costs.

Proposed true-up for satellite data charges

Unlike the en route business, there is no traffic risk sharing mechanism in place in our oceanic business. This means that we are exposed to 100% of the revenue risk if actual traffic volumes are lower than assumed, and equally that we receive 100% of the benefit if actual traffic volumes are higher than assumed.

While the existing framework provides customers with certainty on prices, the proposal to implement satellite based surveillance across the North Atlantic in RP3 necessitates a different approach. These data charges will represent around 35% of the total oceanic cost base. Our best estimate of the total annual cost, along with the traffic forecast levels against which these costs will be recovered, is included in our plan.

We propose that under or over-recoveries of satellite data costs, caused by traffic volume variances, would be trued-up on an n+2 basis. Through this mechanism, if traffic volumes are higher than assumed, customers will benefit from a reduction in the oceanic charge in future years. Conversely, if traffic volumes are lower than planned, the charge would increase in future years.

A pass-through approach for satellite data costs is considered appropriate because of the high degree of uncertainty regarding oceanic traffic volumes during the RP3 period, following the introduction of satellite based services. Airlines have expressed a strong preference for us to negotiate a fixed annual fee with Aireon, rather than agreeing to a data charge that would vary each year based on actual volumes of traffic. Our prices for RP3 will be fixed at the start of RP3, and will be calculated by dividing fixed satellite service costs by estimated traffic volumes. Variances in the volume of traffic between actual and assumed levels could lead to customers significantly overpaying for the cost of the satellite service.

The establishment of two charging zones from 1 January 2020 (Tango and North Atlantic crossing) creates additional uncertainty regarding traffic forecasts. In particular, it is difficult to know exactly how many flights will operate on the new Tango routes that will be established in RP3, and whether or not flights that currently fly in a north-south direction in the south east corner of oceanic airspace each year, but outside of the existing Tango routes, will adjust their flight plans to operate on the new Tango routes. In establishing our fixed prices for RP3, we have assumed that these flights will move to operate on the Tango routes, and that they will pay the lower data charges in this airspace. If they do not move to the new Tango routes, these flights would pay the higher North Atlantic crossing data charges instead. In the absence of a pass-through arrangement, we would over-recover satellite data costs in this scenario, and customers would over-pay. Our proposed true-up is designed to remove this risk.

[4] CPI-X is a method of setting prices using the CPI index of inflation, less a constant percentage each year.

Conversely, it should also be noted that the size of the data charges relative to our oceanic business means that we do not have the capacity to absorb under-recoveries in the same way as for the domestic air traffic services. For example, if oceanic traffic was around 4% lower than assumed, then this would extinguish the entire regulatory return for the oceanic business.

We expect to be able to hedge any currency exposure so that the true-up mechanism referred to above would relate only to the volume related component of any variance between costs incurred and amounts recovered through prices.

Efficiency of satellite data charges

In 2016, we commissioned a study to provide us with assurance that the cost of the proposed oceanic satellite data charges was reasonable, that the supplier, Aireon, would not be making an excessive level of financial return, and that the business model of the satellite hosting company, Iridium, was secure. A range of consultants were considered to undertake this study. We selected Euroconsult, a consultancy with in-depth knowledge of both the satellite industry and the Aireon business specifically. The study included a review of relevant benchmarks for key costs such as hosting fees and administrative costs.

The Euroconsult report from 2016 formed the basis of our opinion that the satellite data charges proposed by Aireon were reasonable. It also provided us with assurance that the level of Aireon's potential financial return was fair, and that it was commensurate with the level of risk faced by the company. We provided airlines with the opportunity to review the report, but this option was not progressed at that time.

During summer 2018, we held a workshop with customers to review the 2016 Euroconsult report. During the meeting, customers confirmed that they understood the approach taken by Euroconsult and that they were content that the report had been independently produced. Airlines requested additional information including the revenue projections underpinning the Euroconsult report. Information was provided after the meeting, but some questions could not be fully answered due to commercial confidentiality. Airlines expressed some concerns around value based charging and raised issues relating to potential cross-subsidisation. We explained that the pricing in our RP3 plan is based on Aireon's global rate card, which we have reviewed extensively. We said we were confident that that the price charged by Aireon was fair, and that the cost:benefit ratio represented a strong business case for customers.

Benefits

Safety improvements

Currently, despite key safety mitigations[5], safety performance is not capable of meeting the ICAO NAT target level of safety (TLS) i.e. NATSPG measure of vertical collision risk, using current PBCS operations. This is expected to worsen with traffic growth acting to raise the number and duration of events.

Our analysis of alternative solutions, which we presented to customers at their request in summer 2018, concluded that increased use of existing technologies (i.e. increased ADS-C reporting rate) or theoretical improvements to the effectiveness of our key safety mitigations would not sufficiently reduce the NAT estimated vertical collision risk to achieve the NAT TLS.

Based on joint analysis by us and NAV CANADA[6], it is estimated that using additional aircraft downlink parameters from ADS-B more frequently would deliver substantial safety benefits. It is estimated that in the Shanwick-Gander oceanic control areas, the vertical collision risk would be reduced by up to 36%, increasing to 76% across the entire North Atlantic if deployed consistently across the NAT. This reflects the performance difference between existing performance with mitigations, and the projected performance after this change is deployed.

The benefits of this improvement will be the integration of aircraft transmitted selected flight level (SFL) information in the ATM system acquired cleared flight level (CFL) to provide controllers with a real-time comparison. They will be able to alert and intervene faster when an aircraft is not intending to, or not flying in accordance with, its assigned flight trajectory or is on a flight trajectory assigned to other aircraft. This will reduce the duration of events and their impact. CFL/SFL checking has been deployed by us very successfully to substantially reduce level busts in UK domestic airspace for many years.

[5] Key mitigations include strategic lateral offset procedure.
[6] Presented to ICAO Separations and Airspace Safety Panel, and NAT Safety Oversight Group.

The predicted benefits of permanently introducing satellite based ADS-B, as part of a NAT-wide roll out, are shown in the table below, based on a sample of data taken during the period 1 July 2015 to 30 June 2016.

	With ADS-C only	With ADS-C plus current safety mitigations	With ADS-B benefits and ADS-C plus current safety mitigations
TLS (fatal accidents per flight hour)		5×10^{-9}	
Performance (fatal accidents per flight hour)	94.4×10^{-9}	19.8×10^{-9}	4.7×10^{-9}

Fuel burn/emissions savings

The five key sources of fuel saving benefits described in this plan are:

> Shorter flight times delivered through better service delivery quality - more aircraft fly the trajectory they ask for;

> Smaller distances between aircraft that will enable more flights to fly closer to their most cost effective trajectory - ASEPS;

> Reduction/removal of mandatory speed control enabling flights to choose their most fuel efficient speed - variable mach/cost index;

> Improved predictability of ASEPS and variable mach operations, enabling reductions in the cost of carrying fuel that is loaded and not used during NAT flights - fuel uplift; and

> Progressive removal of airspace structures and flight planning constraints to enable flights to choose their most cost effective trajectory - user preferred routes/trajectories (UPR).

Fuel savings have been calculated using our oceanic air traffic simulator, consistent with benefit derived data that supported investment decisions for our Project Stamper.

This simulator models oceanic flight trajectories against different ATC separation options, providing a measurable output of the performance difference between each separation option. This is then adjusted for traffic growth estimates to simulate the increasing density of airspace and the consequential impact this has on the performance of each separation standard. The performance of each trajectory within this model is then compared using common industry aircraft performance assumptions[7] to calculate the per flight difference of each option in kg of fuel to derive the final value of each ATC separation option.

Our estimate of the benefits is subject to the following assumptions:

> Traffic growth reflects the North Atlantic FIR forecast produced by NAT EFFG/31;

> Optimum levels do not include further optimisation available from step climbs; and

> Fuel costs have been assessed at US$700 per metric tonne. A sensitivity analysis of the break even point for benefit delivery to justify investment in this plan has been completed at different fuel costs as follows.

Sensitivity analysis of fuel benefits at different fuel costs

	2021 onwards
Per flight break even US$600/mT	183 Kg
Per flight break even US$700/mT	157 Kg
Per flight break even US$800/mT	138 Kg

> The benefits baseline is Project Stamper, which is the best available performance of PBCS separations, assuming full equipage by the NAT fleet; and

> Options modelled used the projected ATC separation standards being prepared by the ICAO Separation and Airspace Safety Panel for core NAT operations are shown below.

	Base case	Option case
Separation dimension	ADS-C/CPDLC/RNP4 standard	ADS-C/CPDLC/RNP2 standard
Same track longitudinal	5 mins	15nm
Lateral	23nm	15nm
Vertical	1,000ft	1,000ft
Intersecting tracks	5 mins	c. 2.5 mins

[7] Base of aircraft data family 4.

Our benefits analysis pre-dated ATC separation standards developed by ICAO[8]. Our customer workshop in August 2018 concluded that the standards modelled and developed are sufficiently similar to support our analysis.

We have considered the alternative of reducing further separation standards based solely on ADS-C that were identified by ICAO in May 2017 and we do not consider this an appropriate option.

The performance and network quality of NAT DataLink and ADS-C services were subject to industry wide concern, including the inability to secure service level agreements from communication service providers, when NAT PBCS operations were introduced in March 2018. Further reductions in separation standards using only ADS-C increases further the demands on this network by tripling aircraft position reporting. We lack confidence in the ability of this network to provide a robust and sustainable service while under increased demand. We continue to seek assurance around timely and essential DataLink service improvements being delivered by multiple stakeholders to support and sustain PBCS and ASEPS operations.

A NAT-wide business case analysis for space based ADS-B, endorsed by NATSPG (NATSPG conclusion 53/4[9]), estimated the average per flight benefit from UPR implementation that has been reflected in our plan between 2022 and 2024. These are shown in the table below.

Summary of NAT EFFG's satellite based ADS-B benefits case

Benefit area	2020 & 2021	2022	2023 & 2024
Shorter flight times	0.3 mins	0.3 - 2.4 mins	
ASEPS implementation		85 kg	
Variable mach/cost index		237 kg	
Avoided fuel uplift		84 kg	
UPR savings	-	122 kg	243 kg
Savings per flight (kg)	406 kg	528 kg	649 kg
Cost saving per flight (at US$700/mT)	US$284	US$370	US$454
Estimated data charge per flight	US$110	US$110	US$110
Net saving per flight	US$174	US$260	US$344

Explanatory points:

> Shorter flight times and fuel reductions are for the entire NAT crossing (Shanwick and Gander).

> ASEPS introduction reflects the vertical optimisation of aircraft using smaller distance based separation standards. This optimisation is projected to enable us to allocate around 91% of all westbound traffic their requested flight trajectory.

> Variable mach reflects the fuel efficiency of enabling around 80% of all NAT traffic to fly at their requested speed range i.e. not allocating an inflexible fixed speed.

> Avoided fuel uplift reflects the projected reduction in the cost of fuel, as less will have to be carried, given the material projected improvement in flying the filed flight plan.

> UPR savings reflect the progressive de-structuring of airspace, including the removal of the organised track system (laterally, longitudinally and then by time). They also reflect the improvements to flight planning to enable more flexible flight/fuel planning by crews, consistent with the simultaneous introduction of free route airspace in Europe. They are based on ICAO NAT EFFG business case analysis[10]. This analysis was carried out using a traffic forecast that was around 1.4% p.a. higher than NATS forecasts.

> Estimated data charge per flight is estimated using an assumed flight time in oceanic airspace of 2.75 hours and an illustrative data cost of US$40/hour.

> Our 2020/2021 benefit estimates were calculated using traffic forecasts of 548,000 ATMs p.a. against our August 2018 forecast of 524,000 - 533,000 ATMs p.a. and are materially comparable.

> Time based savings have not been included in the fuel estimates to ensure that fuel benefits are not double counted, so benefits are expressed conservatively.

> Our benefit predictions were subject to extensive simulation, and measure the difference between the trajectory assigned to each aircraft, and how often they may expect to receive it under different business rules i.e. ATC separation standards. Our predictions therefore differ materially from modelling that compares only what is requested by each aircraft under different business rules i.e. where it is assumed that all aircraft receive exactly what they ask for, and where the likelihood of receiving the requested trajectory is not considered.

[8] ICAO Separation and Airspace Safety Panel (SASP) approval of ASEPS minima, May 2018.
[9] https://www.icao.int/EURNAT/EUR%20and%20NAT%20Documents/NAT%20SPG%20Reports/NAT%20SPG_53%20(2017)%20Report.pdf.
[10] NAT EFFG 32, WP03.

Assumptions and risks

It has been necessary to make some assumptions and assess the risks in order to produce an analysis on which we can base the benefits. Many of the assumptions captured during this process originate from the ICAO agreed NAT business case assessment[11]. We also briefed our customers on these assumptions and risks during our RP3 customer consultation, including the benefits case workshop held on the 16 August 2018.

For each benefit, the assumptions made and risks identified are described below.

Safety benefit

High level assumptions:

> The safety benefit is derived from the estimated reduction in vertical collision risk, taking into account the effect of cleared flight level/selected flight level alerting; and

> This analysis was based on event data NAT-wide covering the period 1 July 2015 to 30 June 2016.

Risks:

> The vertical collision risk calculations are based on the events that were reported in the sample period considered (in this case 1 July 2015 to 30 June 2016) and therefore the vertical collision risk estimates, and consequently the safety benefits, could change depending on events that are reported in the period being analysed.

Advanced surveillance enhanced procedural separation

High level assumptions:

> These benefits were modelled using our oceanic air traffic simulator (OATS);

> OATS does not contain the organised track structure (OTS);

> Eurocontrol's base of aircraft data (BADA) version 4.0 was used;

> Seven sample days were simulated and then annualised based on historical averages;

> Annual traffic/growth was based on 2015 traffic and grown in accordance with NAT EFFG/31 growth rates; and

> Non-ADS-B separations are very high frequency and required navigation performance 2 based on TELSTAR.

Risks:

> Use of the OTS was not modelled (this is not considered material because the base case and ASEPS case seek to follow the same aircraft trajectories); and

> Separations modelled were based on expected ASEPS, before ASEPS had been agreed (we consider modelled separations v ASEPS to be comparable).

Fuel uplift

High level assumptions:

> 3% fuel reduction per hour;

> As hourly benefit is compounded, each kg of fuel saved would reduce the overall fuel consumed by 1.159 kg; and

> Fuel uplift scope is performance based communication and surveillance plus ASEPS.

Risks:

> Fuel reduction per hour could be different from 3% (however we have assumed a conservative 3% reduction per hour).

[11] NAT SPG/53 report Appendix D - NAT space based ADS-B business case assessment.

Variable mach

High level assumptions:

> Massachusetts Institute of Technology analysis concludes that benefits of up to 2.4% are considered feasible;
> Analysis (using OATS) indicated around 80% of flights can be safely allocated no assigned mach in an ADS-B environment; and
> We therefore considered the proportion of traffic that can be allocated minimum separation plus a variable mach buffer that can be provided with a 1.5% fuel burn reduction during the oceanic phase.

Risks:

> Variable mach benefit may be different from a 1.5% fuel burn reduction (our analysis has assumed a conservative 1.5%).

User preferred routings

High level assumptions:

> We have used the NAT average values from the NAT EFFG business case analysis of space based ADS-B, endorsed by the NATSPG in June 2017.

Risks:

> Our UPR benefits are based on analysis led by the Federal Aviation Administration, subsequently endorsed by the ICAO NATSPG; and
> UPR benefits are based on ICAO's EFFG traffic forecast. This analysis was subject to scrutiny from all NAT stakeholders at EFFG, prior to gaining endorsement by the ICAO NATSPG and its members.

Further opportunities

In addition to the benefits described above, the opportunity to use oceanic ATS surveillance data to better predict arrival times in dense terminal airspace, in particular to reduce the overall level of airborne holding, was discussed during our airport consultation. Heathrow Airport and Gatwick Airport supported this. We will work with key airports across the UK/Ireland network. Our contract permits us to utilise ATS surveillance data in this way.

Working in partnership with the IAA, there may be an opportunity to further relax the minimum mandatory equipage for aircraft, utilising the south east corner of NAT airspace. This would require careful examination by ANSPs and airlines.

Key risks

There is a risk that the assets needed to deploy key deliverables of this plan, in particular the ATM system and ATS surveillance, are not available in time. We will mitigate this risk through:

> An aligned development, assurance and deployment plan between our suppliers of the ATM system and ADS-B and us; and
> ATS surveillance data service charges protected by contracts based on regulatory approval, formal purchase orders and delivery of services that meet our strict service level agreement.

In addition, there is a risk for our customers that the benefits of ADS-B in adjacent oceanic airspace may not be fully realised if there are constraints on capacity in our controlled airspace.

> This will be mitigated through a close working relationship with other oceanic ANSPs, and joint development and deployment of service improvements across NATS and NAV CANADA service areas.

Alternatives

During our summer benefits workshop we explored alternative approaches to delivering the safety and fuel efficiency benefits of this plan with customers, specifically the potential to derive greater benefits from existing ADS-C technology and strategic lateral offset procedure (SLOP) process compliance.

We reported on joint NATS and NAV CANADA analysis of the potential benefit from increased ADS-C reporting. There was customer consensus that:

> Increasing the reporting rate of ADS-C would yield zero benefit using a like-for-like data sample for our benefits; and

> Using 2016 calendar year data may yield a 3% safety benefit that does not materially improve safety risk within this airspace.

We also reported on customer requests to explore the benefit that increased effectiveness of SLOP may reduce safety risk. These are summarised in the table below, with expanded ADS-C reporting, based on a sample of data taken during the period 1 July 2015 to 30 June 2016.

Collision risk mitigation option	Base case	Option case
TLS (fatal accidents per flight hour - fapfh)		
Estimated vertical collision risk (no SLOP)	94.4×10^{-9} fapfh	56.8×10^{-9} fapfh
Estimated vertical collision risk (current SLOP)	19.8×10^{-9} fapfh	12.6×10^{-9} fapfh
Estimated vertical collision risk (increased ADS-C reporting)	19.8×10^{-9} fapfh	12.2×10^{-9} fapfh
Estimated vertical collision risk (optimal SLOP)		8.9×10^{-9} fapfh
Estimated vertical collision risk (ADS-B + CFL/ SFL & reduced event duration)	4.7×10^{-9} fapfh	2.3×10^{-9} fapfh

We jointly explored the use of increased ADS-C reporting to provide further additional benefits. Our conclusion is that while this presents theoretical possibilities to improve flight efficiency, our significant experience of operating with these technologies and data vendors provides us with substantial doubt as to the effectiveness of this, including:

> Increasing ADS-C reporting rates delivers no material safety benefit;

> The sustainability and service resilience of increasing ADS-C reporting rates have not been fully considered or assured by communication service providers;

> ADS-C communication service providers cannot currently provide a service level agreement for existing ADS-C services which support today's larger separation minima; and

> Deployment of ATS surveillance is consistent with the NAT service development roadmap and the deployment plans of neighbouring NAT service providers.

Appendix N: Financial assumptions

The CAA has challenged us to own and justify the assumptions underlying our business plan.

The assumptions in this business plan have formed a key consideration in the formulation of our proposed targets, costings and pricing, as well as the feasibility of the performance of the plan itself. At the outset of the business plan process, we set out the assumptions we proposed to underpin our plan to the CAA in September 2017. At the time, we requested that, if, during the course of reviewing our business plan, the CAA considered any assumptions to be inappropriate, that they inform us at the earliest opportunity.

Ultimately these assumptions are a critical part of our plan. Any subsequent assessment of our performance during RP3, including in relation to compliance with our Licence obligations, must take account of these assumptions and the trade-offs between capacity, environment and cost they give rise to in setting our prices.

In particular, our business plan should be read with the following qualifications in mind:

> The plan has necessarily been prepared on the basis of assumptions that are outside our control. For example:

  – The RP3 EU-wide regulatory framework is not yet known, so we have prepared our plan on the basis that the existing (or a materially similar) regulatory framework will continue to apply. As details have emerged of future changes to the regulatory regime that are sufficiently certain, we have built these into our assumptions and provided an explanation of how these changes, if implemented, would impact our plan.

  – The RP3 EU-wide performance targets have not yet been finalised. In September 2018, the PRB issued advice to the EC on how these targets could be set. If the cost efficiency targets were adopted unamended and applied to the UK, then we would not be able to deliver the outcomes of this plan. Our high level overall assessment and rationale is set out in Appendix I. Our plan assumes that the targets comprised within it will be sufficient to satisfy the UK's contribution to the final EU-wide target.

  – Our plan is based on our August 2018 traffic forecasts, the basis for which is set out in Appendix B. We note in particular that the unpredictable outcome of Brexit means that there is increased uncertainly and risk around our traffic forecast.

  – Our wider plan is particularly reliant on factors that are currently uncertain, including actions to be taken by the Government and the CAA, including modifications to our Licence and cost base. The assumptions that form the basis for our wider plan are based on discussions we have had to date with the CAA and others about these matters.

> In reaching these assumptions, we have taken into account the priorities and feedback of airline customers, airports, the CAA and their consultants. As these assumptions have evolved during the RP3 customer consultation, where relevant, we have updated our plan accordingly.

> Some of these assumptions rely on actions to be taken by others, such as the CAA. As such, we will only be able to deliver the outcomes that we propose, for example in relation to the wider plan, if others fulfil their obligations and take actions that we ourselves cannot fulfil or perform. Where future changes to our Licence and/or our cost base are required, this would require further consideration in due course, according to the applicable regulatory processes.

> While we have made every attempt to ensure that our assumptions are sufficiently reasonable and robust to justify them forming the basis for our plan, there is inherent uncertainty. Therefore, there remains a risk that they will prove inaccurate or that they will be superseded by events that cannot reasonably be foreseen.

> If, during the course of the RP3 process, there is good reason to believe that one or more assumptions may no longer be appropriate, we will need to revisit these and their implications for the business plan as a whole. Therefore, if we consider any of the assumptions forming the basis for our plan are likely to be sufficiently inaccurate so as to have a material impact on the deliverability of our plan and the outcomes that our customers expect, we will advise the CAA and seek guidance from them on how to take account of this in the UK performance plan.

The remainder of this appendix sets out the assumptions underpinning our financial modelling for RP3.

Inflation

The inflation assumptions used in our plan are sourced from the June 2018 Oxford Economics forecast published in July 2018.

June 2018 Oxford Economics inflation forecasts

Inflation	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Average calendar year CPI	0.0%	0.7%	2.7%	2.4%	1.8%	1.6%	1.7%	1.8%	1.9%	2.0%
Average calendar year RPI	1.0%	1.7%	3.6%	3.5%	3.0%	2.9%	3.0%	3.5%	3.6%	3.5%
	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
Average financial year CPI	0.1%	1.1%	2.8%	2.3%	1.6%	1.6%	1.7%	1.8%	2.0%	2.0%

The following indices are used:

Eurocontrol, oceanic[1] and London Approach income and pay:	Average calendar year consumer price index (CPI)
Elements of non-staff costs and non-regulated income:	Average financial year CPI
Regulatory asset base (RAB) value:	Average calendar year RPI

Note: RPI is used to inflate both the RAB and in the calculation of regulatory depreciation and return. The methodology for determining the value of the RAB is consistent with the approach taken during RP2. Oxford Economics provide the RPI forecast that we use.

Traffic

The traffic forecasts used in our plan are sourced from our internal forecast of August 2018, as shown in detail in Appendix B.

Summary details of the key assumptions for en route flights and chargeable service units (CSU) and oceanic flights are shown in the table below.

August 2018 en route and oceanic traffic forecasts

Eurocontrol en route – calendar years	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
En route flights (000s)	2,295	2,425	2,516	2,533	2,546	2,597	2,653	2,713	2,769	2,802
En route CSUs (000s)	9,975	10,711	11,606	11,938	11,947	12,073	12,351	12,676	12,985	13,218
Oceanic en route – calendar years	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
En route flights (000s)	440	475	498	508	513	524	533	546	559	569

[1] In RP2, oceanic income used August to August CPI indexation.

Pensions

Appendix H describes the company's pension arrangements and the actions taken to control these costs. The pension rate projections used in our plans are shown in the table below.

Total NERL pension costs

2017 CPI prices (calendar year) £m	2015 Actuals	2016 Actuals	2017 Actuals	2018 Forecast	2019 Forecast	2020 Plan	2021 Plan	2022 Plan	2023 Plan	2024 Plan	RP2 Total	RP3 Total
Cash contributions												
– Future service	60	57	44	37	36	46	45	44	42	40	235	218
– Deficit repair	22	23	30	30	31	18	18	19	19	–	137	74
Defined benefit	**83**	**80**	**75**	**68**	**67**	**65**	**64**	**63**	**60**	**40**	**372**	**292**
Defined contribution	4	5	6	8	10	11	13	14	15	16	32	68
Pension cash alternative	–	1	11	18	17	17	16	15	14	13	48	74
Total pension costs	**87**	**86**	**91**	**93**	**94**	**93**	**92**	**91**	**89**	**68**	**452**	**433**
As a % of pensionable pay												
– Future service	29%	29%	32%	32%	32%	42%	42%	42%	42%	43%		
– Deficit repair	11%	12%	22%	26%	27%	17%	17%	18%	19%	–		
Defined benefit	**40%**	**41%**	**53%**	**58%**	**59%**	**58%**	**59%**	**60%**	**61%**	**43%**		
Defined contribution	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%		
Pension cash alternative	–	28%	28%	26%	26%	27%	27%	27%	27%	26%		
Total pension costs	**37%**	**37%**	**42%**	**39%**	**39%**	**37%**	**36%**	**36%**	**36%**	**28%**		

The values in the table above reflect our latest actuals/estimates for all years of RP2, rather than the allowance/assumptions made by the CAA. Some totals may not add due to rounding.

Accounting guidelines

Our business plans are prepared on the basis of the international accounting standards, including new accounting standards that we are required to implement in the plan period.

We are assessing two accounting standards: IFRS15 - Revenue from Contracts with Customers, which deals with revenue recognition; and, IFRS16 – Leases, which were issued by the International Accounting Standards Board in May 2014 and January 2016 respectively. IFRS15 is effective from the 2018/19 financial year and IFRS16 is effective from the 2019/20 financial year. The potential impacts of these two standards are reflected in our business plan.

Based on our initial assessment, we expect IFRS15 to require an adjustment to equity, to reflect RP1 pension pass-through revenue, which was previously deferred and remains to be recognised, and for RP2 pension pass-through to be recognised as revenue, following its approval by the CAA/EC during early RP3. For performance plan purposes, pension cost variances from unforeseen financial market conditions are assumed to be recovered through an adjustment to the unit rate in RP3 and subsequently, in accordance with SES Regulations and the Licence. Variances arising in RP2 are assumed to be approved after the end of RP2. The RAB is depreciated to reflect the recovery of pension pass-through in the unit rate.

IFRS16 introduces significant changes to lessee accounting, with the distinction between operating and finance leases removed and, as such, assets and liabilities are recognised on our balance sheet in respect of all leases. The charge for operating leases will be reflected in our income statement through depreciation of the right of use leased asset and a finance cost for the lease, rather than a rental charge. The impact of this standard is not expected to be material to our income statement.

For performance plan purposes, the contractual lease rental charge is included in operating costs, on the same basis as prior to IFRS16. Equally, additions made to our balance sheet for right of use assets and related liabilities are not reflected in the RAB.

IFRS9 – Financial Instruments, which replaces IAS39, is also effective from the 2018/19 financial year. The impact of IFRS9 is not expected to be material to our financial statements. No adjustment has been made to our determined costs for performance plan purposes.

Tax

Our business plan assumptions reflect the Finance Act 2017/18. The rates of corporation tax assumed in the plan are as follows:

> 19% - 2017/18, 2018/19 and 2019/20; and

> 17% - 2020/21 onwards.

The rate of capital allowances claimed is as follows:

> 18% on a reducing balance basis for the plant and machinery main pool; and

> 100% on research and development assets.

An allowance for corporate tax charges is included in the cost of capital. Research and development tax credits are claimed, where applicable, under the large company scheme at a rate of 12%. Income derived from patents is taxed under the patent box regime.

Financing

Our Licence includes a gearing target and cap of 60% and 65% respectively, with a tax claw back mechanism that operates in this range. This is to ensure that our financial structure is sufficiently robust to withstand credible downside stress tests and still enable us to continue investing and delivering our business plan outcomes.

If our gearing, as measured by net debt to RAB, exceeds 65%, then we are precluded from paying dividends and must provide details to the CAA of the steps that we would take to reduce gearing to below 65%. If average gearing in the current reference period exceeds the target level of 60%, we lose the interest tax shield on the part above 60%.

We maintain a portfolio of debt diversified by source and maturity. The group's borrowings include a £600m 5.25% amortising bond maturing in 2026 (£382m at the end of March 2018) and bank loan facilities at variable interest rates. To achieve an economic hedge of the impact of inflation on part of its regulated revenue, we entered into an amortising index-linked swap (final maturity 2026) with an original notional principal of £200m (£176m at the end of March 2018) whereby we receive fixed interest at 5.25% and pay interest at a rate of 3.43%, adjusted for the movement in the retail price index (RPI). Our bank facilities of £400m expire in July 2022; they are currently undrawn.

Our plan assumes that further bonds are issued during RP3, and that the bank facilities are refinanced, each in a manner that supports the funding requirements of our business. These assumptions have been supported by a detailed financeability analysis of the plan, based on a target credit rating of A/A2.

Dividends

Our dividend policy is to pay a regular and progressive dividend that reflects our cost of equity and any regulatory out-performance.

In addition, it includes consideration of the potential for, and affordability of, returning any excess capital to shareholders, taking into account our gearing and overall liabilities.

Dividends assumed in RP3 would increase our gearing at the end of this reference period to around 60% net debt:RAB if all plan assumptions are fulfilled.

Pay

Our pay assumptions reflect the level of remuneration that we consider necessary to retain and attract employees. If our prices do not materially reflect our assumptions then we will need to adjust the content of our plan and its outcomes. See Appendix J for more details on benchmarking.

Capital expenditure plan

Our capital expenditure plan does not take account of any possible future impact on the need to re-plan interim milestones due to supplier delivery performance. This highly integrated plan will continue to need to be refined as a result.

Appendix O: Economic regulatory model

This appendix describes the key features of our existing economic regulatory model, along with adjustments that we are proposing. This is in line with CAP 1625, in which the CAA invited us to suggest regulatory mechanisms or changes to the regulatory regime.

The framework presented is subject to potential change following decisions that European and UK regulatory authorities make in RP2. If there are material changes to the regulatory framework, we will need to adjust the content of our plan and its outcomes.

See introduction to Appendix N for more details on our approach to the assumptions that underpin our plan.

Regulatory model

Our plan covers three regulated services:

> En route service (regulated under the European and domestic regime);

> London Approach service (regulated under the European and domestic regime); and

> Oceanic service (regulated under the domestic regime only).

The UK en route unit rate is the aggregate of the following components:

> NERL: Costs of providing UK en route services;

> CAA: Costs for safety and airspace regulation activities;

> Department for Transport (DfT): UK's allocation of Eurocontrol fees; and

> Met Office: Costs of providing weather forecasts for civil aviation.

Our business plan concerns only our portion of the UK en route unit rate. We expect that other elements will be covered in the national consultation on the UK Performance Plan in 2019.

London Approach and oceanic charges are also covered in this plan.

Building blocks

Economic regulation for en route services follows a price cap model, which specifies an aggregate cost of providing air navigation services for which we will be remunerated via user charges in each year of the regulatory period (determined costs). The determined costs comprise the following core building blocks:

> Efficient operating costs: Operating costs (opex) make up the majority of our cost base, including staff costs (including cash pension costs), non-staff costs and exceptional items;

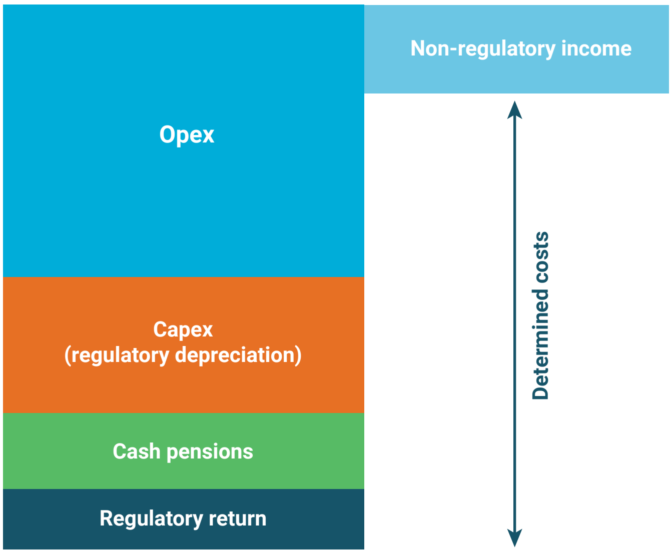
> Depreciation of the regulated asset base (RAB): We need to fund capital investment (capex) to develop the infrastructure necessary to provide the required level of services to customers in RP3 and beyond. In line with commercial practice, the costs of this investment are spread over prices charged to customers over 15 years, rather than being recovered in full in just a single year;

> Regulatory return (weighted average cost of capital (WACC)): The final building block of determined costs provides a return to our providers of capital on a fully commercial basis. This covers the costs of debt and tax as well as providing a market based rate of return to shareholders reflecting our underlying risk. The regulatory profit is calculated as the size of the RAB multiplied by the cost of capital; and

> Single till (non-regulated) income: Determined costs are calculated net of certain other of our sources of revenues, such as London Approach income, revenue from our future military area radar service contract with the Ministry of Defence, North Sea helicopters and an allowance for generating ancillary revenues from non-regulated sources.

The diagram illustrates how determined costs are calculated by adding the main building blocks and subtracting single till revenues.

Building blocks of our regulatory model



En route prices

Our component of the UK unit rate is calculated by dividing our determined costs by the forecast service units (traffic). This is the determined unit cost (DUC), and is the metric currently applied by the EU to measure cost efficiency improvements. We expect the EC to adopt EU-wide targets in 2019.

In practice, the unit rate actually paid by customers each year is calculated by applying a number of adjustments to determined costs. These include:

> Traffic risk sharing: Actual traffic levels may be either higher or lower than the forecast traffic levels in the agreed performance plan. The difference in revenue that arises from any variation of actual traffic to forecast traffic levels is shared between airlines and air navigation service providers (ANSP). Currently, the risk sharing mechanism applied is set out in the charging regulation (EU) No 391/2013. Under this current mechanism, there is no risk sharing when actual traffic is +/-2% from the assumed forecast; for traffic variations between +/-2% to +/-10% of the assumed forecast, the risk is shared 70%/30% between the airlines and us respectively; and for traffic variations more than +/-10% from the assumed forecast, we respectively gain no benefit and are exposed to no risk;

> Inflation adjustment: The price is adjusted for the difference between the forecast inflation underpinning determined costs and the actual level of inflation;

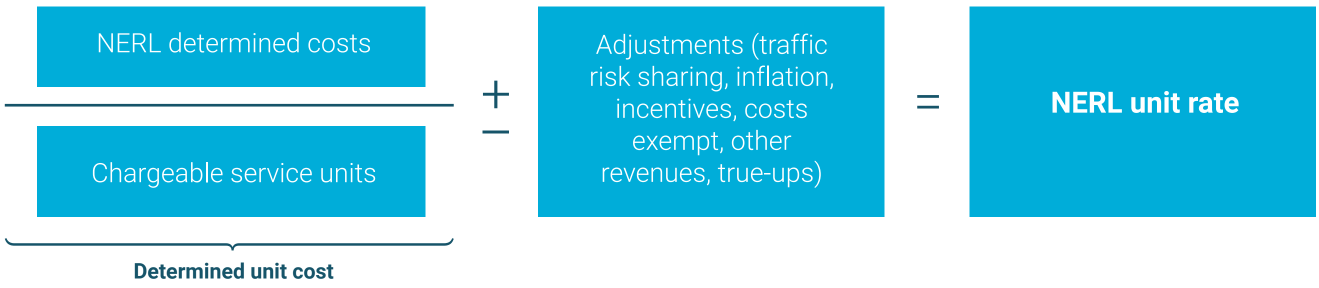
> Incentives: The payment of penalties to customers or bonuses by customers for under/over performance respectively;

> Costs exempt from cost sharing: This includes the risk/saving on certain cost items, for example cash pension costs, and means that the difference between the assumptions underpinning determined costs and actual costs is borne/rebated in full by/to airspace users. Currently the costs exempt from cost sharing are set out in the charging regulation (EU) No 391/2013;

> Other revenues: This includes Innovation and Networks Executive Agency funds that are passed through to customers in accordance with the mechanism set out below; and

> True-ups: This term accounts for any deviation between actual and assumed traffic levels, which would otherwise result in us either under or over recovering the adjustments described above.

The most recent draft European regulation, published August 2018, proposes changes to the adjustments described above, including the traffic risk sharing mechanism and treatment of inflation. As there will not be any certainty over the applicable European regulatory framework until November 2018, for the purposes of this plan, we assume that the existing (RP2) European regulatory framework remains in place and that the adjustments described above are made to the DUC to obtain the unit rate.



London Approach prices

The London Approach determined costs are calculated by applying cost allocation drivers to the en route determined costs. These were reviewed by the CAA and their consultants in 2014. A further review by the CAA's consultants of our cost allocation drivers for RP3 is currently underway. We do not currently intend to adjust the cost allocation drivers for RP3. However, if changes are required as a result of the CAA's review, we will request that the CAA reflect these in the draft UK Performance Plan.

As is well known by our customers and the CAA, London Approach prices are not fully reflective of cost. In 2014, the CAA stated that they would be inclined to move towards a London Approach charge that is fully reflective of the costs incurred over time, in line with a common approach across the EU. Information that we supplied the CAA and their consultants to enable them to determine the approach to cost reflectivity for London Approach charges in RP3 is provided below. We understand that the CAA will consult on an approach in 2018.

In the absence of any further guidance from the EU and the CAA, and any representations from our customers for change, we have maintained the same level of cost reflectivity in the London Approach prices for RP3 in this plan. However, if changes are required as a result of the CAA's consultation, we will request that the CAA reflect these in the draft UK Performance Plan.

The London Approach service is not currently included within the scope of en route cost efficiency targets. London Approach revenues are deducted from the en route determined costs via the single till mechanism.

For RP3, we are assuming that London Approach will be subject to traffic volume risk sharing on the existing terminal service unit basis that is used in RP2. In establishing London Approach prices for RP3, we have created an implied London Approach RAB using the same methodology as we used in RP2. Our prices also apply the same cost of capital for London Approach prices as we use for en route prices.

Further information on the cost reflectivity of London Approach

Cost reflectivity

Historically, the amount of London Approach's cost in the terminal charge has been around 40% of the total service line operating costs, depending on the impact of traffic and the various cost drivers for allocating costs between our businesses. In this plan, 38% of London Approach's operating cost is in the terminal charge, which is within the historical range.

In addition, we have performed assessments based on radar mapping following a similar methodology to some other European ANSPs. This provides strong evidence to suggest that our current allocation of London Approach between terminal and en route is justifiable, noting that the London Approach service contains both en route and terminal elements. However, adopting this more complex methodology would add an administrative burden.

For completeness, information is provided below that:

i. Allocates all of London Approach costs to the terminal charge; and

ii. Allocates all of London Approach costs to en route.

Unit rate / price					
2017 CPI prices (calendar year) £	2020	2021	2022	2023	2024
London Approach					
Status quo (before traffic, other adjustments)	12.27	11.76	12.05	11.89	11.93
All in terminal	42.84	42.05	43.71	46.07	45.90
All costs en route	–	–	–	–	–
En route					
Status quo	54.34	50.91	49.86	48.69	46.32
All in terminal	51.65	48.26	47.08	45.72	43.37
All costs en route	55.42	51.94	50.91	49.72	47.36

Impact on airlines from a change in allocation of determined costs

The table below shows that the top ten London based carriers would benefit from all terminal charges going into the en route unit rate compared to the status quo. However, the opposite is true for all costs going into terminal. The extent of the benefit or dis-benefit depends on how extensively different airlines use the London Approach service.

Winners and losers assuming £1m of determined cost transferred from London Approach to en route for each year of RP3 based on 2017 traffic data

Net impact of change in determined cost	Terminal (decrease)/increase	En route (decrease)/increase	Net (decrease)/increase
	£	£	£
British Airways	(1,529,168)	591,032	(938,137)
easyJet	(607,063)	397,460	(209,603)
Ryanair	(459,977)	480,257	20,208
Virgin Atlantic Airways	(170,266)	88,201	(82,065)
American Airlines	(117,700)	122,508	4,808
Wizz Air	(122,041)	45,596	(66,445)
Emirates	(95,685)	83,276	(12,409)
United Airlines	(84,652)	190,556	105,904
Thomson Airways	(78,140)	108,337	30,197
Aer Lingus	(70,276)	136,389	66,113

From a policy perspective, it is unclear that a change in the basis of pricing for London Approach is better than the status quo. However, this is a decision for the CAA.

Area	Status quo	All terminal	All en route	Commentary
Cost reflectivity				None of these approaches is fully cost reflective.
Stakeholder views				A move away from the status quo will create winners and losers so is likely to be unpopular.
European consistency				A variety of approaches is adopted across Europe.
Simplicity				The status quo is understood by stakeholders while the implications of a change might be challenging to explain (even though the intuition is straight forward).

Inclusion of London Biggin Hill Airport in London Approach

The CAA have asked us to explain how our plan would be affected if the cost of providing London Biggin Hill Airport with an approach service was included in London Approach charges, rather than being billed as part of a separate commercial arrangement. As background, the London Biggin Hill Airport approach service is similar to that provided to other airports included in the scope of London Approach, using shared equipment and resources. This means that there would be very little impact of including it in London Approach, which is explained in the assessment table below. However, this is a decision for the CAA.

Area	Assessment	Explanation
Operation		There would be no material impact on the operation, including safety, capacity and environment outcomes.
Unit rate		The loss of the London Biggin Hill Airport contract in the single till would increase the en route unit rate by 1p per service unit.
Administration		The small size of aircraft at London Biggin Hill Airport would create an administrative burden and/or income loss for us. This could be addressed if we billed London Biggin Hill Airport directly and then London Biggin Hill Airport recovered the charges from their customers.
Stakeholder views		There was no feedback from customers.
Similarity with neighbouring airports		This would align London Biggin Hill Airport with other major London airports.

London Approach price					
2017 CPI prices (calendar year) £	2020	2021	2022	2023	2024
London Approach charge					
Without London Biggin Hill Airport (status quo)	12.27	11.76	12.05	11.89	11.93
With London Biggin Hill Airport[1]	12.24	11.73	12.02	11.86	11.90
En route Eurocontrol unit rate[2]					
Increase in en route Eurocontrol unit rate	0.01	0.01	0.01	0.01	0.01

Oceanic prices

Oceanic prices are determined in a method consistent with International Civil Aviation Organisation (ICAO) principles. Our oceanic model and proposed changes to the way oceanic prices are determined are described in Appendix M.

Planning assumptions

We have based our business plan on a set of key regulatory and financial planning assumptions, which we described to the CAA in September 2017, and are fundamental to this plan. The key regulatory planning assumptions are as follows:

> There is no change to the current structure of London Approach charges or method of calculation, which will continue to be in line with CAA guidance in CAP 1158[3];

> The existing pension pass-through mechanism is retained;

> Pass-through of RP2 capex is allowed where we meet customer consultation and efficiency tests, and the pass-through mechanism is retained as in RP2; and

> The existing traffic risk sharing mechanism will continue to apply as it has done for RP2.

See Appendix N for a description of our financial assumptions.

[1] The addition of London Biggin Hill Airport increases the amount of traffic in London Approach without causing costs to rise, which means that the cost per service unit falls overall. Given that we do not currently have an estimate for terminal navigation service units (TSNUs), traffic at London Biggin Hill Airport is based on an initial estimate of 2,600 TNSUs that grows in line with other traffic.
[2] This is due to loss of income from the London Biggin Hill Airport contract that offsets determined costs.
[3] Regulatory treatment of London Approach charges in Reference Period 2 (2015-2019) of the Single European Sky performance scheme: CAA Conclusions issued in 2014.

The EC published its third iteration of the draft performance and charging scheme regulation for RP3 in August 2018. At the time of writing this plan, it is not clear the extent to which the proposed changes will take effect. Therefore, we have assumed that the existing RP2 regulatory framework is retained for the purposes of this business plan.

If there are material changes to the regulatory framework, we will need to adjust the content of our plan and its outcomes.

A number of the EC's proposals would have implications for the assumptions used to develop this plan, including adjustments to the traffic risk sharing mechanism, treatment of inflation, incentive schemes, and changes to the traffic forecast assumptions. We will request that the CAA reflect the necessary adjustments to the building blocks/outputs of our plan when they develop the draft UK Performance Plan.

Financial incentive schemes for RP3

We propose two financial incentive schemes in the areas of capacity and environment. These are broadly based on the RP2 financial incentive schemes, which we consider remain fit for purpose, and are well understood internally, by the CAA, and by customers. However, we propose that incentive schemes should apply only at national level, rather than at functional airspace block (FAB) level, to ensure that ANSPs are not unfairly rewarded or penalised for events outside their control. This requires amendment to relevant articles of the charging and performance regulations.

We note that the most recent draft of the European performance and charging scheme regulation mandates asymmetric incentive schemes for capacity, based on either the C1 or C2 metric, and allows member states to set additional symmetric incentive schemes (capped at 1%) on other metrics, including environment. It is also unclear to what extent other delay targets can be financially incentivised with the capacity 3% penalty or 1% bonus, such as delay at peak times (C3) or one off delays (C4). Therefore, our proposed incentive schemes are subject to change, depending on the requirements of the European RP3 regulatory framework.

Our proposed schemes are symmetrical, with bonuses/penalties capped at 1% of revenue each year for each scheme. Bonuses/penalties are payable in year n+2. This matches existing schemes.

There is wide regulatory precedent for symmetric incentive schemes in the UK. For example, under their RIIO price controls, Ofgem adopted symmetric incentive schemes in aggregate, offering a fair balance of rewards and penalties for companies.

Penalty-only or asymmetric schemes, in which the percentage revenue exposed in the penalty regime is greater than the percentage revenue available as a bonus, are typically used by regulators to discourage performance slippage.

As we need to balance the resources required for our day-to-day service with the resources required to evolve our service to provide future capacity, we believe a symmetrical scheme is appropriate to avoid unduly penalising us for optimising our performance outcomes in both the short and longer term. Also, as our customers continually seek further performance improvements, we believe a balance of incentives is appropriate.

There is another reason for believing that asymmetric incentive schemes are not in the best interests of our customers. This is because prices would need to increase for the corresponding increase in the cost of capital that would be required to ensure our investors are remunerated for the additional level of risk they are exposed to.

The current 2% cap on penalties already represents a material proportion (19%) of our regulatory return[4]. Increasing the cap beyond 1% of revenue, for each of capacity and environment, could expose our regulatory return to a disproportionate level of risk, magnified by our operational gearing. Depending on the extent of exposure, this could impact our financeability and would have implications for our cost of capital.

Capacity incentive scheme

The proposed incentive scheme is based on our capacity metrics (C1, C2, C3 and C4), as set out in Appendix E. Therefore, we propose that the C1 metric is no longer used in the incentives mechanism as it would expose us to financial risk through causes of delay that are outside our control. The current RP2 regulations permit this approach.

Our proposed par values are set out in Chapter 3. We propose to retain current gradients of the sliding scales for the financial incentives (FC2, FC3 and FC4).

[4] This is based on an average RP2 regulatory return of £61m (2017 CPI prices), and average forecast en route determined costs of £588m (2017 CPI prices).

The bonus/penalty is calculated as follows:

> Total bonus = FC2 + FC3 (in a 1:2 ratio, up to a maximum bonus of 0.5% of revenue); and
> Total penalty = FC2 + FC3 + FC4 (in 1:2:1 ratio, up to a maximum penalty of 0.5% of revenue).

For FC2:

> There is a deadband of -20% to +10% around the C2 par value (so bonuses are paid when delay is less than 80% of par value, and penalties are incurred when the delay is more than 110% of the par value); and
> Bonuses/penalties are accrued on a smooth sliding scale where maximum bonus is at 40% of par value and maximum penalty is at 150% of par value.

For FC3:

> The par values are modulated in the event of unexpectedly high or low (4% each way) levels of traffic;
> Bonuses are accrued on a smooth sliding scale up to a maximum bonus; and
> Penalties are accrued on a smooth sliding scale up to a maximum penalty.

For FC4:

> No bonus is payable;
> Where C4 < the par value, no penalty is payable; and
> Where C4 >= the par value, penalties are accrued on a smooth sliding scale up to a maximum penalty.

As described in Appendix E, in place of the existing exemption days, we are proposing a special event transition delay allowance. Allowances would be consulted on and agreed annually through the service and investment plan (SIP) process. Delay incurred above these allowances would count towards our capacity metrics.

Environment incentive scheme

The proposed incentive scheme is based on our refined 3Di, as set out in Appendix G.

The financial incentive (F3Di) is calculated in line with the following principles:

> There is a deadband around the par value;
> Bonuses are accrued on a smooth sliding scale up to a maximum bonus (of 0.5% of revenue); and
> Penalties are accrued on a smooth sliding scale up to a maximum penalty (of 0.5% of revenue).

Regulatory mechanisms

In this section we present our proposals for the evolution of regulatory mechanisms required to support the wider plan: Future Airspace Strategy (FAS) Facilitation Fund and Opex Flexibility Fund (OFF).

We assume that other regulatory mechanisms relating to capital expenditure and pension costs remain unchanged.

Proposals for the evolution of the FAS Facilitation Fund

The FAS Facilitation Fund (FFF) was introduced in the UK-Ireland FAB Performance Plan for RP2 by the CAA in order to mitigate some of the risks to the delivery of the FAS programme, as stated in CAP 1249[5]. This was a replacement for an operating cost contingency allowance, which had previously been a feature of our price settlements. The fund is financed through our component of the UK en route unit rate for RP2, and comprises two elements as described by the CAA in CAP 1249.

> A Small Gaps Fund to address key areas of misalignment between costs and benefits that might deter some third parties from making investment critical to realising the network benefits of FAS; and
> A NERL fund for us to address unforeseen activities required to deploy the FAS related projects and/or realise the benefits.

The fund is governed by the FAS Deployment Steering Group (FAS DSG), which approves any expenditure. The group is composed of representatives from airlines, airports, general aviation, the DfT and the CAA. Any funds not invested in the FAS Programme will be returned to customers in RP3 in a net present value (NPV) neutral way.

[5] FAS Deployment Facilitation Fund, issued in 2015.

We agree with the FAS DSG's response to CAP 1593 that the Small Gaps component of the FFF should be financed via the DfT or the CAA element of the unit rate as we are not eligible to recover costs from this fund. Therefore, this component of the FFF does not feature within our plan.

Under the current rules, we may be allocated funds from the NERL fund as FAS related operating expenditure. We believe this component of the FFF should be discontinued in RP3 for two reasons: first, the fund has limited scope as it applies to FAS related projects only; and the governance process restricts our ability to secure funds quickly to respond to changing conditions and requirements. These factors restrict the fund's usefulness.

We believe a better approach would be to allow for an additional core plan capped Opex Flexibility Fund (OFF), described below, with corresponding true-up mechanisms to ensure the best outcome for both our customers and us.

Proposals for a core plan Opex Flexibility Fund

To address the shortcomings of the FFF described above, our core plan contains an additional OFF, providing flexibility for us to deliver the most cost efficient outcome for customers. The OFF is not a direct replacement for the FFF as the scope is much wider. The OFF would not be restricted to FAS related activities and so could be used to deliver customer benefit of any category. It would provide us with flexibility to deliver the most cost efficient outcome for customers.

The fund would only be used in certain pre-defined circumstances and capped so that we would bear the risk on any overspend. Similar to the current FFF, any unused funds at the end of RP3 would be returned to customers in an NPV neutral way as soon as possible in RP4. If additional funds were required, we would bear that risk. The value of our proposed fund reflects this arrangement. It should not be a limiting factor on our ability to deliver additional customer benefit, where agreed through the appropriate governance process.

The fund would be governed and reported on via the SIP process and used for:

> Switching between opex and capex: Providing flexibility for us to deliver a project using a different mix of operating and capital expenditure from that envisaged by the core plan, thereby minimising the overall cost. This allows projects to be delivered using the most efficient and effective means; and

> Delivery of core plan programmes: Allowing us to address key risks or unforeseen circumstances, to ensure that the core plan can be delivered on time and that transitions are implemented smoothly.

More detail is set out below.

Switching between opex and capex

In previous price settlements, technical solutions have largely been delivered using capex. However, technological advances mean that opex solutions are now becoming more available to us.

Our core plan reflects our current best view of how we will meet customer requirements through our investment plan and operating activities. The costs associated with these, whether capex and/or opex revenue, are reflected in the regulatory building blocks for prices in RP3.

It is likely that other more efficient possibilities for meeting customer requirements may develop during RP3 with a different mix of capex and/or opex to that envisaged in the core plan. This could provide the following benefits:

> Better strategic solutions with higher overall economic value through lower total costs over the lifetime of the solution; and

> Incentivisation for us to deliver projects and activities in the most efficient manner without being constrained by the type of expenditure mix. Under the current framework, there is a disincentive for us to do this.

The mechanism will deliver the benefits of a total expenditure (totex) approach, which has regulatory precedent in a number of other sectors, including the water and energy sectors.

Areas where the mix of expenditure could vary materially, and which would be eligible to use the opex/capex switch mechanism during RP3, include:

> Software licencing: Where a switch away from acquiring and capitalising the cost of licences (capex) to subscribing for software product as a service (opex) could lower the total cost;
> Software hosting: Currently we host software on our servers (capex). Benefit could be delivered by using third parties hosting software (opex);
> Future service model: In line with our service based model, opportunities may exist to buy in services from third parties (opex) rather than building in-house solutions (capex); and
> Infrastructure support costs: We currently outsource development of enhanced software (opex). In the future, better value might be achieved through in-house development (capex).

We would consult customers on any such projects and activities falling within the scope of this mechanism through the established SIP engagement and consultation process, setting out the changed costs and benefits and impact on prices. The resulting agreement with customers would be outlined in the submitted SIP.

The switching mechanisms would work as follows:

> Switching to opex from capex:
  – The additional opex cost would be recovered from the OFF annually; and
  – The reduction in total assumed capex in RP3 would be reflected in a lower RAB (in line with existing rules), in the next regulatory period i.e. capex that is recovered in RP3 but not spent, is returned to customers at the start of RP4.
> Switching to capex from opex:
  – The increase in total capex in RP3 would be added to the RAB (in line with existing rules), and remunerated through charges in the next regulatory period; and
  – The avoided opex spend would be returned to customers at the first opportunity on an n+2 basis.

For example, for a project that the core plan assumed would cost £3m of capex but which could instead be delivered with £2m of opex (including timing adjustments), subject to customer consultation, we would return the capex costs to customers at the beginning of RP4 on a NPV neutral basis. The opex incurred in RP3 would be remunerated from the OFF. Customers would benefit from a total saving of £1m (including timing adjustments).

We will be talking to customers in more detail about how the OFF would work in practice through our discussions on the enhanced SIP process.

Delivery of core plan programmes

The OFF will be used to support delivery of our core plan programmes. The fund allows us to address a number of key and specific risks that could arise during the reference period. Examples include additional costs to:

> Meet new or changing customer requirements and priorities, for example, hot spots;
> Deliver planned customer benefits on time and to reduce the operational impact of transitions, particularly where delivery could be at risk through events outside our control, for example, risk of programme delays caused by our supply chain;
> Deliver even greater efficiencies in our operation from opportunities we may identify, which would lower our underlying cost base and prices in future reference periods;
> Deliver changes to ATCO terms and conditions to ensure delivery of plan commitments, for example, where overtime or rostering efficiencies do not deliver sufficient additional staff to meet the operational and project needs; and
> Allow us to undertake appropriate feasibility and options studies when new technologies become available, to identify whether the customer benefits warrant the investment.

The use of the fund will also deliver the best outcome for customers because, without the fund, we would be required to include a level of contingency in our operating costs. The existence of the fund would result in customers only paying for risks that crystallise.

The use of the opex fund to address the specific risks identified above would be reported via the SIP process. This balances the need for us to be able to respond quickly and flexibly to changing conditions, with the need to provide assurance to customers that the fund is being operated efficiently and only on truly additional spend. We would also be happy for the independent reviewer to monitor and report on use of the fund.

Proposals for wider plan regulatory mechanisms

We have proposed a regulatory mechanism to deal with specific items/events identified in the wider plan. The mechanism is fully described in Chapter 7.

Aireon data charge – pass-through mechanism

This proposed mechanism is described in Appendix M.

Summary of regulatory mechanisms - opex

The table below shows the proposed opex regulatory mechanisms for RP3.

Proposed opex regulatory mechanisms in RP3

	Eligible costs	Benefit	Governance	Financial mechanism
Core plan: FAS Facilitation Fund (NERL component)	Not retained	Not retained	Not retained	Not retained
Core plan: Opex Flexibility Fund	Opex/capex switch: Specific projects/items identified in the business plan. Delivery of core plan programmes: Costs incurred to mitigate specific risks identified in the business plan.	Provides flexibility for us to deliver items by most cost effective means. Allows us to respond quickly to changing conditions to ensure progress is made on investments that are important to customers. De-risks delivery of complex capital expenditure programme. Avoids need to price in risk at individual project level, enabling more efficient prices for customers.	Business case for fund use to be submitted to SIP or ad-hoc meeting/ WebEx with request for customer response within one month Regular reporting (via SIP) on status of spend.	Fund allowance built into core business plan ex-ante, and recovered from customers via annual unit rate. Funds may be spent on operating cost items or on capex where an opex/ capex switch decision has been agreed via the SIP. True-up at end of reference period for any underspend (unused funds to be returned to customers as soon as possible in RP4). The allowance is capped meaning there is no provision for overspend.
Wider plan mechanism	Costs (operating and capital) related to specific items/events identified in the wider business plan.	Appropriately shares and minimises cost risk for specific items/events. Reduces financeability concerns. Reduces customers' exposure to forecasting uncertainty.	Bespoke engagement or SIP deep dive.	No ex-ante cost allowance. Costs recovered ex-post, subject to appropriate consultation with CAA and customers.
Core plan: Aireon data charge pass-through mechanism	Aireon data charges incurred in provision of oceanic service.	If traffic volumes are higher than assumed, customers benefit from a reduction in oceanic charges on n+2 basis in RP3 and in the next reference period. Protects financeability of oceanic service if traffic falls short of forecast.	Subject to ex-post review at end of reference period.	Assumed Aireon data charges are built into prices ex-ante. Any deficit/surplus in aggregate Aireon data charges collected by us (caused by variations in traffic) is trued-up on an n+2 basis in RP3 and in the next reference period.

Draft regulatory policy statement on pension costs

In Appendix H we highlighted the benefits of a regulatory policy statement related to our defined benefit pension scheme costs. Such a statement could provide trustees with greater assurance and also help contain pension costs. A copy of a draft statement that we have shared with the trustees is set out below:

Policy principles relating to defined benefit pension scheme costs ("Pension Costs")

What we expect from NERL and/or Trustees of the NATS Section of the Civil Aviation Authority Pension Scheme ("the Pension Scheme")

Principle 1: Efficient Pension Costs

1. Airspace users should only pay for costs that are efficiently incurred and not those which are excessive or avoidable by efficient management and/or Trustee action.

2. We expect NERL to behave in a manner consistent with a commercially minded company by taking all steps available to it within its legal discretion, which are in the interests of users, and working with the Trustees to take actions to manage and mitigate the pension cost burden on airspace users.

3. NERL should demonstrate that it has done all it can to mitigate the burden on airspace users arising from the company's pension obligations.

Principle 2: Appropriate actuarial valuations

4. Pension Costs should be assessed by the Trustee using actuarial methods, on the basis of reasonable assumptions in line with current best practice taking into account the strength of the employer's covenant and reflecting our enduring commitment to fund Pension Costs.

5. We expect the level of scheme funding to be assessed on the basis of forward looking assumptions regarding long-run investment returns and other key variables by appropriately appointed actuaries.

6. The pension deficit at any formal full actuarial review should be funded over a reasonable period thereafter, taking into account the strength of the employer's covenant, our enduring commitment to fund Pension Costs and prevailing guidance from the Pensions Regulator (tPR).

7. We expect NERL to provide evidence of benchmarking of Trustee valuation assumptions against those adopted by Trustees operating schemes in sectors of the economy open to normal commercial and competitive pressures.

Principle 3: Good stewardship

8. We acknowledge Trustees are not subject to economic regulation by the CAA and are governed by separate pensions legislation and regulated by the Pensions Regulator ("tPR"). Notwithstanding this, we expect to see evidence of good stewardship of the Pension Scheme to ensure that airspace users do not bear costs from a material failure in stewardship. The CAA expects the Trustees to operate the scheme in accordance with all relevant regulations, guidance from tPR and industry best practice standards of governance.

9. We expect the company to play an active role in ensuring the good and effective governance of the Pension Scheme.

10. When establishing the allowances for Pension Costs we will seek actuarial advice on NERL's projections for a reference period. In particular, we will have regard to the assumptions supporting those projections, including the outcome of any recent Trustee valuations of the scheme, and the stewardship of the scheme.

Principle 4: Long-term funding and investment strategy

11. In considering the long-term funding objective of the Pension Scheme, and the investment strategy required to deliver this, we expect Trustees to take into account the strength of the employer covenant including the reliance that can be placed on the stability of the economic regulatory regime.

12. Although a pension deficit represents a fixed obligation, its valuation is subject to change caused by exogenous factors, including for example a fall in the value of stock markets, real interest rates, or changes in longevity assumptions. Some of these factors can be managed through the investment strategy adopted by the Pension Scheme. There is a balance to be struck between taking higher levels of investment risk with the aim that the additional returns expected will result in lower ultimate Pension Costs and taking too much investment risk which could lead to a more volatile funding position and potentially higher deficit contributions.

13. As the Pension Scheme is closed to new members, there is an expectation that the Pension Scheme will mature quite quickly, as active members retire or leave the Pension Scheme (either through leaving employment with NERL or taking the pension cash alternative). At the point where the membership is predominantly formed of pensioners, it is our understanding that the Trustees will want to invest in assets to generate income and cash flows which are expected to match the benefit payments to pensioners.

14. There are various investment strategies which could achieve this including buy-ins and buy-outs, and we expect that the cost implications for NERL's contributions are appropriately taken into account when deciding on the strategy.

Principle 5: De-risking and treatment of surpluses

15. As referred to above, as the Pension Scheme matures we expect that an increasingly risk reducing investment strategy would be developed. This could involve rebalancing from riskier to less risky assets, employing and/or increasing hedging, buy-ins, buy-outs and other risk-reducing approaches. In considering these options and the pace of de-risking, we would expect Trustees and NERL to take account of the relevant costs both now and in the future, taking advice from experts as appropriate.

16. Given the regulatory assurance that this policy statement provides (i.e. that Pension Scheme costs will be remunerated subject to the conditions set out), we would expect consideration to be given to applying any emerging surplus both to de-risking and to lowering NERL's pension contributions to reduce the burden on airspace users who are funding the Pension Scheme when it is in deficit.

17. Although we understand that the risk of any trapped surplus (a surplus that cannot be resolved through contribution holidays) is remote, we expect the Trustees and NERL to minimise the likelihood of this arising. This is likely to be achieved by a measured and balanced approach to de-risking alongside reduced contributions.

The assurance we will provide to NERL and to Trustees.

Principle 6: Remuneration of future service cost and deficit repair contributions

18. We recognise that the funding of its pension liabilities is a legal obligation on NERL and hence a necessary cost of the operations, which must be fully reflected in its pricing.

19. We acknowledge that Pension Costs projected for each reference period are only estimates of the actual cost and will vary over time for reasons outside NERL's control. For these reasons, the Pension Costs reflected in NERL's pricing will also need to vary over time.

20. Subject to NERL and/or Trustees fulfilling their obligations, we commit to the continued full funding of future service costs and any deficit repair contributions associated with NERL's Pension Costs by way of revenue allowances in relevant reference periods.

21. Our funding commitment does not cover any element of Pension Costs that are attributable to the activities of other entities within NATS group which are outside the scope of NERL's Licence. Liabilities in respect of the provision of pension benefits that do not relate to the regulated business should not be taken into account in assessing the efficient level of costs for which allowances are made in a reference period.

Principle 7: Pass-through for the above to the extent allowed by EU regulation

22. The statutory regime which governs the funding of defined benefit pension schemes requires actuarial valuations to be performed at least every three years. This is not aligned with NERL's five-year reference periods. As a result, the level of cash contributions that NERL is required to make to the Pension Scheme may vary, including for reasons outside of NERL's control, from the allowances assumed in the performance plan. Where variations arise between actual and determined costs due to unforeseen changes in national pension law, pension accounting law, or unforeseen financial market conditions, SES regulations pass through the difference to airspace users.

23. We will apply the provisions of SES in determining pension pass-through. Should the UK withdraw from the SES framework following Brexit, we would propose to maintain at least the same approach to pension pass-through.

Principle 8: Stability of regulatory regime

24. We believe that a stable regulatory framework over the long term provides Trustees with greater confidence in the company's ability to meet its legal obligations to support the Pension Scheme. For airspace users who bear these costs, this ensures efficient levels of contributions through a long term funding objective and investment approach which retain an appropriate level of risk and return.

25. Assuming that NERL and Trustees fulfil their obligations, we commit to maintaining principles 6 and 7 above for the foreseeable future. Any changes to this policy would be subject to consultation with stakeholders, including airspace users, NERL and Trustees, and the notice period for implementing any such changes would be aligned with the notice period of NERL's Licence.

Appendix P: Cost of capital

Introduction

In this appendix, we set out our proposed estimate of the company's efficient cost of capital for RP3. The evidence and assumptions associated with these proposals are in five sections:

> Cost of equity;

> Cost of debt;

> Gearing;

> Tax; and

> Overall cost of capital for RP3.

In formulating our proposals for an efficient cost of capital, we have considered and provided supporting evidence for the following, which were expressly referenced in the CAA's guidance to us (CAP 1625):

> Regulatory precedent published since the RP2 decision;

> Market evidence on cost of capital parameters;

> Business risks; and

> Risks arising from external factors, for example, uncertainty arising from Brexit.

We have also considered in detail PwC's analysis (November 2017) on the cost of capital for Heathrow Airport Limited (HAL) for H7, which begins in 2020, and, to a lesser extent, the provisional cost of equity from Ofwat for the water sector for PR19 and the provisional cost of equity from Ofgem for RIIO-2.

We have sought advice from NERA Economic Consulting in relation to preparing this proposed cost of capital for RP3.

We concluded that an appropriate estimate of the efficient cost of capital, for our business plan, expressed on a pre-tax real basis, is 5.07%. This represents a reduction, relative to the cost of capital allowed in our RP2 prices, of 79 basis points (bps)[1].

Furthermore, the proposed reduction in pre-tax, real weighted average cost of capital (WACC) to 5.07% represents a continuation of the downward trend in our pre-tax cost of capital since CP3/RP1- see table below.

WACC from CP3/RP1 onwards (real)

	CP3/RP1 - actual	RP2 - actual	RP3 - proposed
Vanilla WACC	5.54%*	4.25%	4.51%
Pre-tax WACC	6.77%	5.86%	5.07%

* Converted to an accounting rate of return to be consistent with RP2 and proposed RP3 rates.

Although the pre-tax, real WACC is lower than for RP2, the proposed vanilla, real WACC of 4.51% is 26bps higher. In the sections that follow we set out the evidence that supports this increase.

[1] RP2 cost of capital is 5.86% pre-tax, real.

This vanilla, real WACC point estimate of 4.51% represents the mid-point of NERA's proposed range for RP3, and reflects risks under our current regulatory regime (see NERA's reports, available separately on the CAA's website). This point estimate does not take account of any potential changes to the regulatory regime for RP3, such as the proposed changes to the Single European Sky's (SES) regulatory framework in relation to traffic risk sharing, the possible introduction of asymmetric incentive schemes and mandatory use of STATFOR forecasts. Should these changes come into force for RP3, they are likely to have a significant impact on the risks to which our business is subject, and mean we would have to reassess our position on cost of capital.

This appendix explains that the main drivers for the reduction in the pre-tax WACC are a lower cost of debt and a lower tax uplift. These more than offset an increase in the cost of equity to a level that adequately reflects our risk. In summary, our WACC proposal reflects:

> The full extent of the risk that existed in RP2 but was not fully recognised in our WACC for RP2 and remains unchanged;

> An increase in the total market returns assumption that reflects the latest empirical evidence based on both historic and forward looking data, in a manner that is consistent with the Competition and Markets Authority's (CMA's) determinations for Northern Ireland Electricity (NIE) and Bristol Water; and

> Market evidence on the beta parameters that shows betas for comparators have returned up towards the pre-financial crisis level.

Cost of equity

We considered the following in order to form a view on the cost of equity:

> Regulatory precedent and indications published since the RP2 decision;

> Market evidence on cost of capital parameters;

> Business risks; and

> Risks arising from Brexit.

Regulatory precedent since RP2 and recent indicative ranges for total market return (TMR)

Recent regulatory precedent for TMR

Regulator	Applied to	Year	Real TMR point estimate
CMA	NIE	2014	6.50%
CAA	Designated airports	2014	6.25%
Ofcom	Telecoms	2014	6.30%
UREGNI	NI Water	2014	6.50%
Ofgem	Electricity distribution	2014	6.50%
Ofwat	Water	2014	6.75%
Ofcom	Business connectivity	2015	6.10%
CMA	Bristol Water	2015	6.50%
UREGNI	NI gas distribution	2016	6.50%
Ofcom	Wholesale local access	2018	6.10%
Range			**6.10–6.75%**

Recent indicative estimates for TMR

Regulator	Applied to	Year	Real TMR point estimate
Ofwat	PR19 (indicative)	2017	4.85 – 6.13%
CAA	HAL H7 (indicative)	2017	5.1 – 5.6%
Ofgem	RIIO-2 (indicative)	2018	5.0 – 6.5%

Recent regulatory precedent suggests that investors would expect the TMR to be in the range of 6.1% - 6.75% and, as shown below, the long run historical evidence for UK TMR supports the upper end of this range. Conversely, the recent indicative estimates for TMR from Ofwat, CAA and Ofgem are not representative of the long-run historical evidence and as such, are not considered by NERA to be justified. A key driver for these lower indications of TMR is the use of selective forward looking estimates. In relation to this, NERA have considered the approach taken previously by the CMA.

The CMA, in their 2014 and 2015 decisions, explicitly considered both long-run historical evidence and forward looking estimates in reaching their point estimate for TMR of 6.50%. NERA have updated the CMA approach for NIE with the latest available data. This analysis supports there being no reduction in TMR since 2014. In other words, the TMR for RP3 should be no lower than 6.5%.

Updated analysis of evidence considered by the CMA for NIE in 2014

Method	CMA NIE 2014 evidence	Latest evidence
DMS long run (historical ex-post)	6 – 7%	6.2 – 7.1%
DMS decomposition (historical ex-ante)	5.5 – 6%	6%
Fama-French (historical ex-ante)	5.25 – 6.25%	5.27 – 6.27%
Bank of England DDM (forward looking)	5 – 6%	7.1 – 8.2%

Source: NERA analysis

Market evidence for TMR

Long run historical evidence

NERA have considered the evidence of long-run historical returns for the UK market, drawing on different holding periods and averaging techniques as considered by the CMA in their NIE 2014 determination (shown in the table below as the bold numbers).

NERA's analysis of the evidence shows that long-run historical returns have not declined in the period since the start of RP2 and that the updated long-run historical evidence points to a TMR range of 6.8% – 7.1%. However, NERA apply a 0.3% reduction to the lower end of this range to account for 2010 changes to the ONS methodology of data collection (formula effect), resulting in a proposed range for TMR in RP3 of 6.5% – 7.1%. NERA make no adjustment to the upper bound due to uncertainty over other offsetting adjustments for the formula effect.

Long-run historical averages for UK TMR

UK long-run historical TMR	Simple average	Overlapping	Blume	JKM
1Y holding period	7.1%	**7.1%**	**7.1%**	**7.1%**
2Y holding period	6.6%	**7.0%**	**7.1%**	**7.1%**
5Y holding period	6.7%	**6.8%**	**7.0%**	**7.0%**
10Y holding period	6.8%	6.7%	7.0%	6.7%
20Y holding period	7.1%	6.8%	6.8%	6.2%

Source: NERA calculations using DMS (2018) and Credit Suisse Global Investment Returns Yearbook 2018, values presented are in real terms and RPI deflated.

NERA consider that, notwithstanding that some regulators have given weight to forward looking indicators, long-run historical evidence on realised UK market returns remains the best available evidence to estimate expected market returns.

PwC, in their November 2017 advice to the CAA, also proposed an adjustment in relation to good fortune in past returns. NERA have highlighted to us their view that, in relation to this adjustment, PwC are overstating the relevance of the comments made by Dimson, Marsh and Staunton, as these comments were for illustrative purposes only, and do not take account of UK-specific data. Furthermore, PwC's proposed adjustments are based on information that has been available to stakeholders for many years, and is not new evidence. UK regulators, the CMA and academics have been aware of this information, yet have chosen not to apply it to adjust long-run historical returns.

Forward looking empirical evidence TMR

In their advice to us, NERA consider that forward looking dividend growth model (DGM) evidence should be treated with caution, given the sensitivity of the results to dividend growth assumptions. As such, NERA recommend relying primarily on long-run historical returns in estimating TMR, and use of forward looking evidence only as a cross-check.

In their advice to CAA, PwC present two forms of analysis on the TMR based on current market evidence: DGM and market to asset ratios.

In relation to dividend growth models, PwC's approach to estimating dividend growth is not consistent with the approach taken by the Bank of England, which provides widely used independent estimates for the TMR. PwC place significant weight on UK GDP forecasts to forecast future dividends, whereas, as highlighted by NERA in their advice to us, FTSE All Share listed companies derive over 70% of their earnings from outside the UK, where forecast GDP growth is currently higher than the UK's. Also, NERA's view is that there is not a reliable academic link between expected GDP growth and expected dividend growth in the short-medium term, and using a simple GDP growth assumption in a DGM as a proxy for future dividend growth is flawed.

By contrast, NERA report that the Bank of England estimate for the real TMR, using DGM, is around 7% - 8%. The Bank of England base their assumptions on expected dividend growth on large databases of consensus analysts' forecasts of future dividend growth, which is regarded as a much better proxy for investors' short-medium term expectations of future dividend growth than GDP forecasts.

The broad range of DGM outcomes is also highlighted by Europe Economics in their advice to Ofwat in December 2017[2]. Europe Economics present a range for TMR, based on DGM of 6.2% - 7.1%, while showing the range of other DGM evidence as 5.0% - 8.6%, although they do note that sometimes it is ambiguous as to whether some of the estimates are RPI- or CPI- deflated.

PwC also estimate the TMR based on market to asset ratios. However, as NERA highlight in their advice to us, PwC's approach to this fails to adequately adjust for important drivers of value and makes methodological errors, including value of non-regulated activities, value of regulated activities unrelated to wholesale, value of pension deficit/surplus, and expected outperformance, which in NERA's opinion understates the implied TMR by 140-170bps.

In CAP 1610[3], the CAA reference the PwC conclusion that there should be a re-orientation of the evidence towards ex-ante (forward looking) sources, rather than ex-post historical sources when determining the TMR. However, the evidence presented to us by NERA, and by Europe Economics to Ofwat, shows a significant divergence in opinion in relation to what these ex-ante sources are indicating for the real TMR. As such, it is not apparent that a subset of these ex-ante sources, for example, those drawn by PwC, accurately capture investors' expectations of the TMR over RP3. Indeed, the differing views of PwC, NERA and Europe Economics highlight the subjectivity associated with using ex-ante sources, and shows why long-run historical returns continue to be the most objective source of evidence to estimate the expected TMR.

Conclusions on TMR

In forming our view of an appropriate point estimate for TMR, and in keeping with the guidance published by the CAA in CAP 1625, we have considered the long-run historical evidence, recent regulatory precedent including updated analysis of evidence considered by the CMA, and also the forward looking evidence. Taking this on board, and after observing that the data is more supportive of an increase in TMR since 2014 than a decrease, we have adopted as a point estimate for TMR the mid-point of NERA's range, equivalent to 6.8%.

This point estimate lies outside of PwC's estimate for HAL in H7 of 5.1 – 5.6%. However, as explained above, NERA reviewed the methodology that PwC applied, and have provided detailed comments on why these estimates understate the TMR. We recognise that the direction of travel in relation to indicative estimates of TMR by UK regulators is lower than recent regulatory precedent. However, when looked at from the perspective of the sources of evidence used by the CMA in their review of NIE and Bristol Water, we come to the firm conclusion that the evidence points to there being no reduction in TMR since 2014. As such, we consider that the range put forward by NERA is well evidenced and highly plausible.

[2] Europe Economics: PR19 – initial assessment of the Cost of Capital (December 2017).
[3] CAA consultation and policy update: "Economic regulation of capacity expansion at Heathrow", issued in December 2017.

Risk-free rate

NERA have considered the estimate for the risk-free rate under two general approaches:

i) Long-run historical averages; and

ii) Short-run market evidence.

A review of long-run estimates of the risk-free rate by NERA, based on UK government bond yields over the period 1900-2017, suggests a rate of 2.4%.

NERA's review of the short term market evidence showed that the current UK ten-year government yields are around -1.7% (in real terms), and that forward rates indicate that the market expects these yields to increase to -1.1% by the mid-point of the RP3 period.

Based on this evidence, NERA consider 1.5% a plausible upper bound for RP3 based on greater weight being placed on long-run historical market evidence than on short term market conditions. They consider -1.1% a plausible lower bound for the real risk-free rate in the current macro environment, given real interest rates lie comfortably below zero at present.

Asset beta (and other business risks)

NERA have undertaken a detailed review of the appropriate asset beta for us in RP3. This review considered:

> Whether the CAA's relative risk based approach at RP2 remains appropriate for setting the beta in RP3;

> What form any relative risk assessment should take in RP3; and

> The latest market evidence on the betas for relevant benchmarks.

NERA concluded that a relative risk assessment remains the most suitable method for assessing our asset beta for RP3. Furthermore, they concluded that a relative risk assessment should be conducted against listed international airports and not Heathrow and Gatwick. This is because Heathrow and Gatwick are not listed and therefore their betas must themselves be estimated using other listed airports. We believe that removing the intermediary step of conducting a relative risk assessment of us against Heathrow and Gatwick avoids the risk of additional estimation error.

NERA's advice to us on asset beta is a proposed range for RP3 of 0.56 – 0.66. The lower bound is equal to the two-year asset beta of Aeroports de Paris (ADP). They considered that ADP represented a suitable lower bound for us because it is partially protected from traffic risk under its regulatory regime, similar to the way in which we are. NERA added that given our high operational leverage, it would expect our asset beta to be above ADP's[4]. The upper bound is based on the two-year asset betas of international listed airports, with less weight on the less similar airport comparators, such as Copenhagen, Fraport and Vienna. NERA have advised that Copenhagen and Vienna are exposed to less traffic risk than we are because these airports negotiate their charges directly with their customers and in this way are able to mitigate traffic risk to a greater extent. Similarly, Fraport is exposed to lower risk as it can call a 'rate case' to amend its prices, for example if traffic risk is greater than expected.

Asset beta estimates for international airports

Airport & estimation window	Two-year	Five-year
ADP (Paris)	0.56	0.52
Fraport (Frankfurt)	0.54	0.46
Zurich	0.86	0.54
Vienna	0.36	0.22
Copenhagen	0.26	0.30
Sydney	0.55	0.47
Auckland	1.01	0.97
AENA	0.59	–
Average	**0.59**	**0.50**

Source: NERA analysis of Bloomberg data up to 10 August 2018.

[4] This assertion is supported by the Competition and Markets Authority (CMA) also accepting that higher operating leverage results in higher asset beta, when considering Bristol Water in 2010 and 2015.

For RP2, the CAA did not adjust our asset beta to recognise our higher operating leverage, even though their consultant calculated that we faced higher operational cost intensity. By contrast, the asset beta range that is proposed by NERA does, as indicated above, include recognition of our operating leverage. This approach is also supported by the CMA's adjustment to asset beta in relation to Bristol Water, which was made without needing to derive a perfect measure of operating leverage.

For RP2, the CAA's consultant argued that even if our operational intensity is higher than Heathrow's, this does not necessarily demonstrate that we have higher operating leverage. They argued that a large portion of our operating costs relate to the labour costs for air traffic control officers (ATCOs), which may vary with output. In their report on our asset beta, NERA examined whether the historical evidence shows that ATCO numbers are directly related to our output. Using data over the ten-year period to March 2017, they show that our ATCO growth was not positively correlated to traffic growth, indicating that ATCO headcount is also driven by other factors.

These other factors include the need to maintain a safe service, the complexity of traffic flows and the way in which these present themselves, requirements to support our technology and airspace programmes, advances in technology and airspace design which improve productivity, and lead times to increase or reduce ATCO headcount (as explained below).

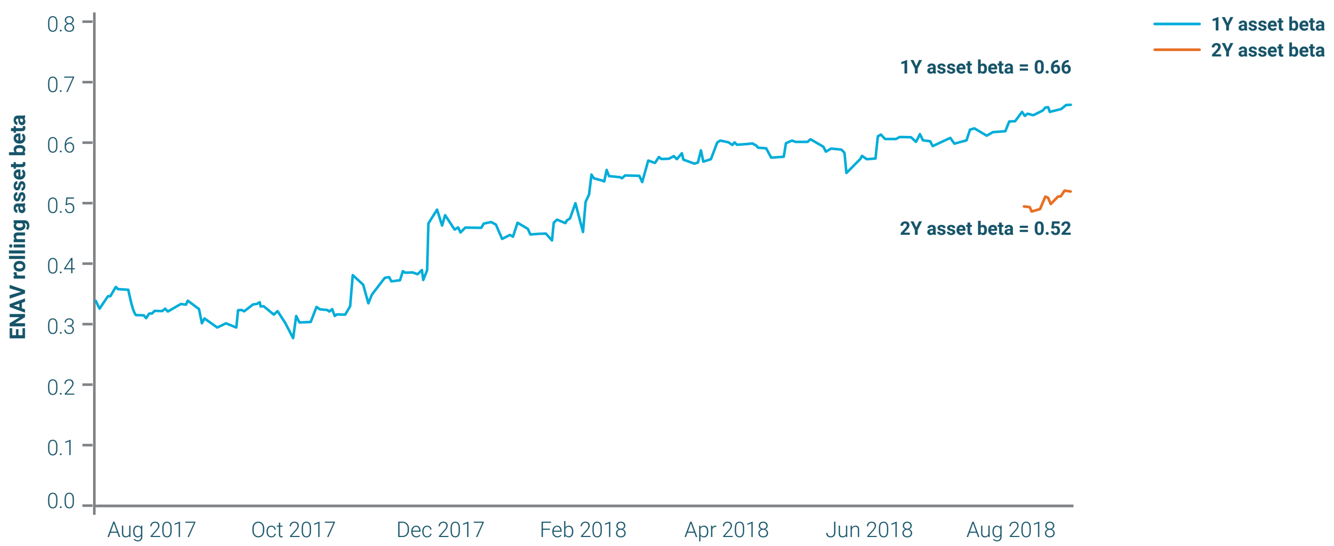
Our experience has been that in the short term, operational staff numbers do not vary materially and their relationship to traffic is non-linear. Numbers can be increased through recruitment and training after a lead time of around three years. Numbers can also be reduced through voluntary redundancy, but not quickly. First, numbers leaving through voluntary redundancy are not under our direct control. Second, we have to exercise a degree of caution before launching such a programme as we need to have sufficient certainty that any related traffic downturn is going to be sustained rather than temporary. It could take time to obtain such assurance. If we release operational resources, only to be faced by a rebound in traffic, this could be very costly in terms of delay because of the around three-year lead time for recruiting and training new controllers.

Given these circumstances, there is evidence to support an adjustment to our asset beta in relation to our operational intensity because we cannot readily adjust our costs to closely match changes in levels of traffic, exposing us to financial risk and greater volatility of returns.

NERA have also considered whether ENAV, the only listed ANSP, could be a useful beta comparator for us. They conclude that while ENAV is a useful beta comparator for us, ENAV's beta estimate should be treated with caution, and adjusted to take into account the key differences between ENAV and us when used as a reference point for our beta. As we explain below, the differences between ENAV and us indicate that ENAV's beta may underestimate our beta.

NERA estimate ENAV's asset beta range to be 0.52 to 0.66 based on one-year and two-year estimation windows. ENAV was listed in July 2016, meaning that there is now enough data to calculate a two-year asset beta. ENAV's asset beta has been increasing since its initial listing, resulting in a fairly steady rise in the one-year asset beta from 0.33 to 0.66. If this rising trend continues, ENAV's two-year asset beta, even prior to country specific adjustments, will likely be within our proposed asset beta range of 0.56-0.66.

ENAV one-year and two-year rolling asset beta



Source: NERA analysis using Bloomberg data up to 10 August 2018.

As referenced above, and in addition to differences in demand risk and customer mix, NERA have presented empirical evidence showing that betas for Italian listed utilities appear to be lower than betas for equivalent utilities in other countries. This suggests that there may be certain specific features in the Italian market that point to the need for the asset betas of Italian companies to be adjusted upwards if being used as comparators for companies listed outside of Italy. NERA observed in their report on our asset beta (issued in March 2018) that the average asset beta for the Italian utilities of 0.24 is 0.08 lower than the 0.32 average for the other European utilities.

In addition, NERA concluded that the betas for UK regulated utilities should not be used to determine the range for our asset beta because it does not recognise the differences in risk between utilities and us, in particular the demand risk and operating leverage. However, NERA observed that the two-year asset betas for UK listed utilities have now returned to pre-financial crisis levels, and also that the asset betas for international airports are exhibiting a similar upward trend.

In relation to debt beta, NERA have adopted the recent approach taken by PwC[5] and used a debt beta of 0.05.

Risks arising from Brexit and possible regulatory framework changes

The assessment above reflects the risks we face based on our existing RP2 regulatory framework and without specific reference to new external factors, such as Brexit. These include:

- Macroeconomic uncertainty, leading to greater downside risk in relation to demand; and
- Regulatory uncertainty, associated with the extent of on-going regulatory alignment by the UK with SES regulation and also the ability of the UK to influence changes in SES regulation that may be detrimental to us, for example, the UK becoming a rule-taker in relation to changes in regulatory approach, including the treatment of pension costs.

Together, these risks, which are not considered to be factored into the asset betas for international listed airports, point to the need for us to have a higher asset beta.

Our proposed range for asset beta of 0.56 – 0.66 does not yet take account of the possible introduction of changes to the regulatory framework. NERA have identified three main changes from the RP2 regulatory arrangements, which, if implemented, could increase our downside risks and could in turn increase our cost of capital. These changes are a proposed asymmetric and higher capacity incentive penalty cap, a higher traffic risk sharing threshold, and mandatory use of STATFOR traffic forecasts.

Cost of debt

NERA estimated that our cost of debt for RP3 is 1.08% (RP2: 2.50%). This estimate is based on combining the cost of embedded debt of 2.13% and the cost of new debt of 0.42% using the weighting 30:70. Transaction costs of 15bps are also included.

Our existing bonds were issued in 2003 at an initial yield to maturity of 5.4% p.a. NERA estimated the cost of existing debt to be 2.13% for RP3, based on this initial yield to maturity and the Treasury's forecasts for the retail price index (RPI).

NERA estimated the cost of new debt after consideration of:

- Current yields on our bonds;
- Forward curves for UK gilts;
- A maturity adjustment as the weighted average remaining life of the existing bonds is currently only around five years; and
- The effect on the cost of debt that the CAA, upon advice from Europe Economics, considered would arise from the company operating with a ten-year rolling notice period.

[5] PwC: Estimating the cost of capital for H7, a report prepared for the Civil Aviation Authority (CAA), November 2017 – page 81.

Calculation of cost of new debt for RP3

Yield on our existing bonds	1.73%	Based on one-month average yield (as calculated by NERA on 10 August 2018).
Forward rate adjustment	0.63%	To reflect the increase in rates up to the mid-point of RP3, based on the UK 10Y gilt curve.
Maturity adjustment	0.78%	Based on the iBoxx A-rated index and an assumption that new debt issuance will have a maturity of around 15 years; a period equivalent to that used for our regulatory depreciation. Our current bond has a weighted average remaining life of c.4 years.
Notice period premium	0.50%	As referenced by the DfT in its September 2016 consultation document, Modernising the Licensing Framework for Air Traffic Services.
Cost of new debt (nominal)	***3.64%***	
Cost of new debt (real)	0.42%	Deflating cost of new debt using RPI forecast of 3.2%.

In relation to the effect of the ten-year rolling notice period, the Department for Transport (DfT) reported[6] that the CAA investigated these concerns on their behalf and had concluded that while other regulated industries have been able to issue bonds maturing beyond the Licence termination notice period, there is a risk premium attached to such bonds of 50bps.

The cost of the existing bonds and the cost of new debt are combined in the ratio of 30:70, reflecting the relatively significant financing needs over RP3[7]. NERA have included transaction fees of 15bps, reflecting the CAA's allowed transaction costs in RP2.

In relation to indexation of the cost of debt, NERA have considered whether moving to a debt indexation approach is appropriate for setting our cost of debt allowance at RP3, given that a number of UK regulators have either already introduced or are proposing to introduce cost of debt indexation in their price controls. Under a debt indexation approach, the cost of debt in each year of the regulatory period is typically determined by the yield on a benchmark index.

NERA concluded, and we agree, that the challenges in selecting the appropriate credit rating and tenor for a debt index mean that debt indexation may not be as practical for us as it is for other UK regulated sectors. Our concentrated debt issuance exposes us to greater risk if any chosen index does not reflect our optimal credit rating and tenor. Therefore, we would encourage the CAA to take these factors into account in weighing the merits or otherwise in moving away from its existing weighted average approach to setting the cost of debt for RP3.

Over the course of RP2, we were successful in being awarded funding from the Innovations and Networks Executive Agency (INEA), some of which has already been received by us. However, the effects on cost of capital of this INEA funding have been excluded from the calculation of cost of debt, on the basis that these funds are not funding our business and will be passed to customers, from 2019 onwards, as soon as we can practically do so.

Gearing

We assume the same notional gearing for RP3 as for RP2 (60% net debt: RAB) in line with the target gearing in our Licence.

The target gearing level referred to above was introduced by the CAA in 2011. This was to ensure that, as a critical part of the UK's national transport infrastructure, we could continue to withstand credible downside risk while continuing to invest and deliver on our performance plan targets for the benefit of customers and other stakeholders. Based on our financeability assessment, a 60% gearing can still allow us to maintain a solid investment-grade credit rating.

[6] Department for Transport consultation: "Modernising the Licensing Framework for Air Traffic Services" (September 2016).
[7] This ratio has been estimated with reference to embedded debt, RAB projections for RP3 and a notional gearing of 60%.

Tax

Consistent with RP2 and RP1, an allowance for corporate tax is included in the WACC, which is expressed at a pre-tax level, based on an uplift calculated to enable recovery of our forecast of corporation tax payments in RP3.

The tax uplift required in our business plan is 12.7% which is significantly lower than the uplift of 37% in RP2.

For RP2, the tax uplift was higher than RP1 (see table below) mainly because regulatory depreciation exceeded capital allowances. For RP3, the tax uplift will reduce as we obtain research and development tax credits and allowances in relation to higher qualifying capital expenditure on airspace design.

Overall cost of capital for RP3

The component parts of the proposed pre-tax, real cost of capital of 5.07% are set out below, along with a comparison against the cost of capital allowances for the last two regulatory settlements, NERA's advice for RP3 and CAP1610.

Proposed WACC for RP3 – compared to previous reference periods

	CAA – CP3/ RP1 allowance	CAA – RP2 allowance	NERA – low for RP3	NERA – high for RP3	Our point estimate for RP3	Comments
Gearing	60%	60%	60%	60%	60%	No change.
Pre-tax cost of debt	**3.60%**	**2.50%**	**1.08%**	**1.08%**	**1.08%**	Significant reduction due to higher proportion of new debt at lower cost than RP2.
Total market return	7.00%	6.25%	6.50%	7.10%	6.80%	Evidence supports a TMR at similar levels to RP1 and RP2.
Risk-free rate	1.75%	0.75%	-1.10%	1.50%	0.46%	Lower, due to current negative real interest rates.
Asset beta	0.6	0.505	0.56	0.66	0.61	Market evidence supports the increase in asset beta (versus RP2).
Equity beta	1.35	1.1125	1.33	1.58	1.45	Calculation.
Debt beta	0.1	0.1	0.05	0.05	0.05	Changed, as per CAP1610.
Post-tax cost of equity	**8.84%**	**6.87%**	**8.97%**	**10.32%**	**9.65%**	Calculation.
Vanilla WACC	**5.70%**	**4.25%**	**4.24%**	**4.78%**	**4.51%**	Calculation.
			4.51% (NERA point estimate)			
Tax uplift	27%	37%			12.7%	
Pre-tax WACC (real)	**7.00%**	**5.86%**			**5.07%**	

Proposed WACC for RP3 – compared to CAP1610 indications for Heathrow (HAL)

	CAP 1610 (HAL) – low	CAP 1610 (HAL) – high	NERA – low for RP3	NERA – high for RP3	Comments
Gearing	60%	60%	60%	60%	No difference.
Pre-tax cost of debt	1.69%	1.76%	1.08%	1.08%	Similar assumptions on cost of new debt. We have greater % of new debt than HAL.
Total market return	5.10%	5.60%	6.50%	7.10%	Estimates used by PwC for CAP1610 do not reflect the CMA's 2014 approach to TMR.
Risk-free rate	-1.4%	-1.0%	-1.10%	1.50%	PwC/CAA methodology is consistent with low end of NERA range.
Asset beta	0.42	0.52	0.56	0.66	NERA's range is supported by beta of listed comparators.
Equity beta	0.975	1.225	1.33	1.58	Calculation.
Debt beta	0.05	0.05	0.05	0.05	No difference.
Post-tax cost of equity	4.94%	7.09%	8.97%	10.32%	Calculation.
Vanilla WACC	2.99%	3.89%	4.24%	4.78%	Calculation.

Appendix Q: Assessing the financeability of our plan

Introduction

In this appendix we describe how we satisfied ourselves that our core business plan is financeable, noting that we have proposed a regulatory mechanism for recovering costs associated with the wider plan, should they become more certain.

We do this by testing the financeability of our plan relative to:

> Our Licence requirements and target credit rating;
> Quantitative factors linked to a range of credible scenarios;
> Qualitative factors upon which our financeability relies and the key challenges and how these might be mitigated; and
> Our overall assessment and conclusions.

Information referred to above includes market-sensitive, forward looking data which we have provided to the CAA.

We also outline the procedures undertaken to demonstrate that the financial model meets best practice standards for a model used for regulatory price control purposes, including appropriate levels of assurance around its logical integrity and usability.

Our Licence requirements and target credit rating

Our Licence requires us to use reasonable endeavours to maintain an investment-grade credit rating and also includes a gearing target and cap of 60% and 65%, respectively, of our RAB. Consistent with this, we consider that our target credit rating should be in the range of A2/A to A3/A-, as indicated below, based on rating agency guidance on how they assess our gearing levels.

Investment grade credit ratings

						Target				
Moody's	Aaa	Aa1	Aa2	Aa3	A1	A2	A3	Baa1	Baa2	Baa3
S&P	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-

Current headline ratings are highlighted in dark blue, and the stand-alone ratings (that ignore any assessment of likely government support) are highlighted in light blue.

The company and its existing bonds are rated by both Moody's and Standard & Poor's (S&P). Our headline rating from Moody's is A2 and this includes the benefit of a one notch uplift as a result of their assessment of the likelihood of extraordinary government support. Our headline rating from S&P is A+, which also includes a similar one notch uplift. Our current credit ratings are therefore consistent with our target credit rating.

We consider this target credit rating range of A2/A to A3/A- to be appropriate. Were a higher credit rating to be targeted, then in our view customers may be adversely affected, as it is likely that higher profit margins and therefore prices would be required to support such a rating.

Similarly, a credit rating lower than this range would be inconsistent with the gearing target and cap in our Licence.

Based on this target credit rating range, we consider that a successful financeability test is one where the evidence indicates no clear expectation that our credit rating would be either higher or lower than this target range for more than a year.

Quantitative factors

We have assessed the financeability of our plan against the quantitative factors relevant to our target credit rating range.

Relevant published guidance from Moody's and S&P is set out below:

> Moody's: an adjusted net debt:RAB ratio above 70% would indicate a possible downgrade, and a ratio below 60% would indicate a possible upgrade; and

> S&P: a ratio of funds from operations (FFO) to S&P adjusted net debt of below 18% would indicate a possible downgrade. No equivalent upside guidance is published.

In addition to this, we have considered the performance of the financial component of our business plan against the following:

- Adjusted interest cover ratio;
- FFO to net interest payable ratio;
- Our financial covenants; and
- Return on regulated equity (RoRE).

Working with NERA Economic Consulting, we have undertaken financial modelling to understand how key risk factors may affect our financeability in RP3 and which provide insights in relation to RP4. These factors are:

- Traffic;
- Operational staff numbers;
- Pay;
- Non-staff costs;
- Non-regulated income;
- Incentive scheme performance (as defined in RP2);
- Inflation; and
- LIBOR.

These factors do not include pension cost risks. This is because we have assumed that the most material of these, changes arising from financial market conditions, would be dealt with through the existing pension pass-through mechanism or by adjusting prices in future reference periods.

These risk factors have been modelled using Monte Carlo simulations with 1,000 random draws from a defined distribution profile for each input risk factor. We have based our distribution profiles for each risk factor on actual data from current and previous reference periods, along with forecast information consistent with our business plan.

Our financial modelling assumes no material change to the existing regulatory framework, in particular:

- The traffic volume risk sharing mechanism;
- Symmetrical incentive schemes that are capped at 1% of UKATS revenue; and
- The current pension pass-through arrangements.

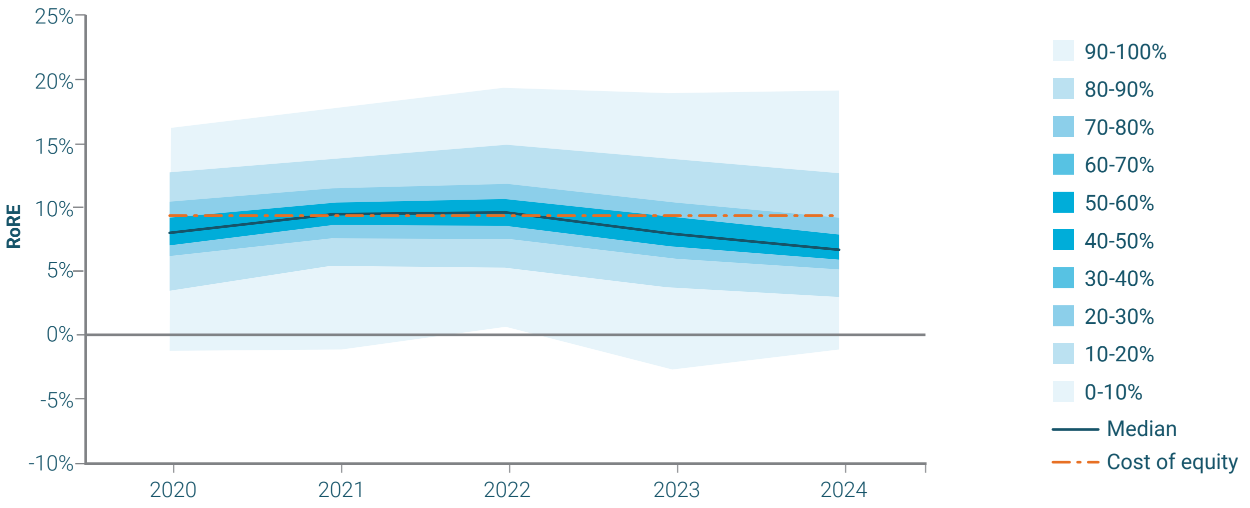
We conclude that on the balance of probabilities, our actual credit rating is likely to remain at or around the target credit ratings. However, in the event that there are material changes in the regulatory framework, we would need to re-perform our financeability assessment tests.

In relation to our post-tax cost of equity assumption of 9.65%, we project that our return on regulated equity will average 8.8% in RP3. This is largely due to the asymmetry of the traffic risk distribution. Our risk analysis also suggests that our RoRE would:

- Remain above our estimated real cost of debt of 1.08% in at least 90% of the scenarios run; and
- Be above our estimated total market return of 6.5% - 7.1% with a confidence interval of around 60% - 70%.

As such, our business plan is considered financeable from an equity perspective.

Our projected RoRE for RP3 with confidence intervals



Qualitative factors

In the paragraphs below, we identify the qualitative factors which currently support our credit rating. In addition, we highlight changes that could undermine our credit rating, together with any potential risk mitigation solutions.

Our Licence

The most significant qualitative factor that supports our credit rating is our monopoly position, secured by a Licence that expires no sooner than 31 March 2031. This is further supported by the financeability duties (as established under the Transport Act 2000) placed on both the CAA and DfT.

The notice period in the Licence of ten years (from 2021) means that this aspect of our Licence may present a financeability challenge towards the end of RP3 and during subsequent reference periods. This has been acknowledged by the DfT (see below).

Prior to the Brexit vote, the DfT proposed extending our Licence notice period to 15 years. This period was chosen to match the average expected useful life of our asset base and to enable us to finance our activities more easily. This change will enhance our financeability. Without it though, there is a risk that future bond amortisation payments, associated with issuing bonds with final maturity dates that match the ten-year notice period in our Licence, could materially impact our financeability in RP4.

Brexit and the stability of our regulatory framework

A second significant qualitative factor is the nature and stability of our regulatory framework. In this respect, the most pronounced short term challenge to our credit rating appears to arise from the potential for adverse outcomes in relation to Brexit, including the nature of any on-going obligations under the Single European Sky (SES) II framework.

In the event that we are required to abide by new SES requirements, without the UK having a significant, or any, voice in relation to any proposed amendments to those requirements, then our financeability could be challenged. For example, if the current pension pass-through mechanism was to be materially altered, then, given the size of our pension scheme relative to our asset base, our financeability could be significantly impaired. Other areas of risk are in relation to the treatment of capital expenditure and the timing of regulatory depreciation, or to true-ups for inflation.

In addition, the European performance and charging schemes are being revised for RP3. The changes are not currently agreed. However, based on the draft RP3 performance regulations presented to the Single Sky Committee in October 2018, changes could include: amendment of the traffic risk sharing mechanism; the introduction of asymmetric incentive schemes; and mandatory adoption of STATFOR traffic forecasts.

Of these potential changes, the most significant for our financeability could be mandatory application of STATFOR traffic forecasts. At the time of preparing our business plan, the STATFOR forecast at September 2018 had not been published. However, in STATFOR's last forecasts (February 2018) there were methodological differences relative to our approach to TSU forecasts that we consider were not appropriate.

The TSU growth forecast by STATFOR was based on the latest trends in flown distance and aircraft weights observed. STATFOR noted that the UK saw particularly strong growth in TSUs in 2017 as a result of transatlantic flights flying more north-about trajectories, due to the position of the jet stream. The STATFOR methodology used the 2017 actual flown distances to project forecast distance flown for future years. This is likely to overstate the UK TSU volumes for RP3. If no adjustment is made for a normalisation of the position of the jet stream, which we have begun to see in 2018, then we expect the September 2018 STATFOR forecast to include an overstatement of TSUs in relation to this factor.

On average the STATFOR February 2018 forecast for TSUs is 1.7% higher than our August 2018 forecast over RP3. The corresponding loss in revenue, if applied to average en route determined costs, equates to19% of our annual en route regulatory return.

If STATFOR forecasts are mandated, we strongly encourage the CAA to take into consideration the methodological differences between our forecasts and those of STATFOR, along with their impact on our expected returns, when determining our cost of capital and assessing the financeability of any performance plan that is based on STATFOR forecasts.

A variety of potential amendments to the traffic risk sharing mechanism have been considered by the EC during 2018. Some of these, if enacted, could reduce the traffic volume risk that we bear (for example, removal of the +/- 2% deadband) and some could increase the risk that we bear (for example, the current +/- 10% threshold increasing to +/- 15%). As such, although it is not possible to establish the likely impact on our financeability at this stage, NERA have demonstrated in their September 2018 report on cost of capital that increasing the threshold from +/- 10% to +/- 15% would adversely affect our expected returns.

Similarly the likely impact of changes to incentive schemes cannot be established in a meaningful way at this stage. However, the latest draft proposals from the EC, if adopted, would introduce asymmetry between capacity bonuses (max 1%) and penalties (max 3%) and make the deadbands smaller. If changes like these are adopted for RP3, they would reduce our expected returns, and we would expect the CAA to take this into consideration when determining our cost of capital and assessing the financeability of the performance plan for RP3. As a reference point, a 3% penalty would equate to around £19m (around 34% of our annual en route regulatory return and around 36% of our total annual return on equity). NERA have also considered what the impact of such a change could be on our expected returns, on the assumptions that performance targets for RP3 remain at the levels set for RP2. In such a scenario, NERA estimate that our expected returns would be reduced by around 30bps.

Once the regulations, performance targets and STATFOR September 2018 forecasts are all published in final form, we will be able to assess the likely impact on our financeability and on our expected returns.

Other qualitative factors

Other qualitative factors that could challenge our financeability, with relevant mitigations, are:

> A relatively small capital base, compared to our operating cost base, which can be partially mitigated by this being reflected in our cost of capital;

> Significant pension obligations relative to the value of equity in the company, which, as referred to above, are mitigated by the current pension pass-through mechanism; and

> A limited ability to raise equity from existing shareholders, which is mitigated by maintaining a detailed, risk based approach to dividends.

Wider plan

Our wider plan covers requirements that remain uncertain at this point in time, including those relating to Brexit, the wider use of drones and evolving cyber security requirements. We propose a regulatory mechanism for addressing these when they are sufficiently mature for us to do so in a practical way. As a result, assurance can be gained that these wider activities would be financeable.

Suitability and integrity of our financial forecasting model

We maintain a financial model which includes regulatory price control functionality as determined by the CAA, and which allows us to test the financeability of different price control scenarios. The financial model was further developed in RP2 with the assistance of external modelling experts. It was designed to conform to the attributes of best practice standards of financial modelling, logical integrity and usability.

In support of RP3, we engaged consultants to undertake limited testing procedures on key aspects of the regulatory price control functionality. The scope of procedures included, for both UKATS and oceanic services, the calculations relating to the price controls, the roll-forward of the regulatory asset bases from the last audited regulated accounts through RP3, the scenario testing functionality, the tax calculations and their consistency with UK legislation, and the tax uplift to cost of capital.

The procedures undertaken in respect of the areas in scope included:

> Inspection of the formulaic code to ensure its mathematical accuracy and conformance with intended logic;

> Inspection of the visual basic code and logic of specific model macros;

> Checking that the assumptions book and input data were consistently reflected in the model;

> Checking that assumptions, input data and calculations are consistent with extracts from relevant documentation (such as the RP2 RAB rules and price controls);

> Checking that the documented impacts of accounting and tax assumptions had been reflected appropriately in the financial model; and

> Checking that the financial model and reports from our business planning and reporting system were consistent with the reconciliation document.

The procedures were limited in scope to those considered to be material to the price control for RP3. Following their review, the consultants concluded that the objectives of the sections of the model subject to these limited testing procedures have been achieved.

Overall assessment and conclusions

In making our overall assessment of the financeability of our plan in RP3, we have considered areas of risk including Brexit, potential changes to our economic regulatory framework and the notice period in our Licence. These risks, and others, could be magnified if the CAA materially reduces our estimate of the efficient cost of capital for RP3.

Based on our plan assumptions, our assessment of the quantitative and qualitative factors above, and on the assumption that there will be no changes in the regulatory regime which will have a material impact on our financeability, we conclude that our business plan is financeable.

The CAA has asked[1] us what appropriate actions could be used to resolve any financeability issues that are also consistent with affordability. If such issues occurred before prices are set for RP3, then solutions include adjustments to: the period of regulatory depreciation; elements of our determined costs, including our regulatory return; and, potentially, some re-profiling of dividends.

[1] CAA letter from Paul Smith to Martin Rolfe, 'NERL's RP3 business plan', 25 September 2018.

Acronyms

ACC	Area control centre
ACE	ATM cost effectiveness
ACM	Airspace capacity management
ADP	Aeroports de Paris
ADS-B	Automatic dependent surveillance – broadcast
AICR	Adjusted interest cover ratio
AIRAC	Aeronautical information regulation and control
AIRE	Airlines representation in Europe
AMS	Aeronautical message switch
ANS	Air navigation service
ANSP	Air navigation service provider
ASEPS	Advanced surveillance enabled procedural separations
ATC	Air traffic control
ATCE	Air traffic control engineer
ATCO	Air traffic control officer
ATFCM	Air traffic flow and capacity management
ATFM	Air traffic flow management
ATSA	Air traffic services assistant
ATM	Air traffic management
A4E	Airlines for Europe
BVLOS	Beyond visual line of sight
CAGR	Compound annual growth rate
CFL	Cleared flight level
CMA	Competition and Markets Authority
CNS	Communications, navigation and surveillance
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CPI	Consumer price index
CPI-X	A method of setting prices using the CPI index of inflation, less a constant percentage each year
CSU	Chargeable service unit
DfT	Department for Transport
DGM	Dividend growth model
DP	Deployment point
DSESAR	Deploying Single European Sky ATM Research
DUC	Determined unit cost
DVOR	Doppler very high frequency omni-directional radio range
DME	Distance measuring equipment
EAMS	Extended aeronautical messaging service
EASA	European Aviation Safety Agency
EBITDA	Earnings before interest, tax, depreciation and amortisation
EC	European Commission
EFFG	Economic Finance and Forecasting Group
EOSM	Effectiveness of safety management
EU	European Union
ExCDS	Extended computer display system
FAB	Functional airspace block
FAS	Future Airspace Strategy
FAS DSG	FAS Deployment Steering Group
FASIIG	Future Airspace Strategy Industry Implementation Group
FASI–N	Future Airspace Strategy Implementation North
FASI–S	Future Airspace Strategy Implementation South
FDP	Flight data processing
FFF	FAS Deployment Facilitation Fund
FFO	Funds from operations
FIR	Flight information region
FMARS	Future military area radar service
FRA	Free route airspace
FTE	Full time equivalent
FUA	Flexible use of airspace
GA	General aviation
GDP	Gross domestic product

HAL	Heathrow Airport Ltd
IAA	Irish Aviation Authority
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
iFACTS	Human machine interface tool
INEA	Innovation and Networks Executive Agency
IPA	Independent parallel approaches
IS	Information solutions
ITIL	Information technology infrastructure library
KPA	Key performance area
KPI	Key performance indicator
LAMP	London Airspace Management Programme
LDC	Less developed countries
LoS	Loss of separation
MOD	Ministry of Defence
MSG	Managerial support grades
NAT	North Atlantic
NATSPG	North Atlantic Systems Planning Group
NIC	Newly industrialised countries
NIE	Northern Ireland Electricity
NOTAM	Notice to airmen
NPP	National Performance Plan
NPV	Net present value
OATS	Oceanic air traffic simulator
OCA	Oceanic control area
OECD	Organisation for Economic Co-operation and Development
OFF	Opex Flexibility Fund
OTS	Organised track system
PAM	Passenger allocation model
PBCS	Performance based communication and surveillance
PBN	Performance based navigation
PCA	Pension cash alternative
PCG	Personal contract group
PCP	Pilot Common Programme
PI	Performance indicator
PPP	Public Private Partnership
PRC	Performance Review Commission
PRR	Performance review report
PRU	Performance Review Unit
P3O	Portfolio, Programme and Projects Office
RAB	Regulatory asset base
RAT	Risk analysis tool
RIM	Rolling incentive mechanism
RoRE	Return on regulated equity
RPI	Retail price index
RTA	Required time of arrival
S&P	Standard & Poor's
SARG	Safety and Regulation Group
SAIP	Swanwick Airspace Improvement Programme
SASP	Separation and Airspace Safety Panel
SES	Single European Sky
SFL	Selected flight level
SID	Standard instrument departure
SIP	Service and Investment Plan
SNIP	Swanwick Network Improvement Programme
SLOP	Strategic lateral offset procedure
SOC	Security operations centre
SOM	Service operations management
STAM	Short term ATFCM measures
STAR	Science, technical, analytical and research
STATFOR	Statistics and forecast service of the Eurocontrol Agency
TEAM	Tactically enhanced arrivals mode
TBS	Time based separation
TMA	Terminal manoeuvring area
TMR	Total market return
TOAP	Trust of a promise
TSU	Total service unit
UPR	User preferred route
UTM	Unmanned aircraft system traffic management
WACC	Weighted average cost of capital

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