ASSESSMENT SUMMARY

		Impact relative to current situation				
Criterion	**Constituency**	**++ve**	**+ve**	**Neutral**	**-ve**	**--ve**
Strategic fit						
Economy	Airport					
	Airlines					
	Passengers					
	Connectivity					
	Employment					
	Public accounts					
Surface access	Road access capacity					
	Rail capacity					
	Journey time					
Environment	Noise					
	Air quality					
	Climate change					
People	Employment					
	Housing & demolition					
	Vulnerable groups					
	Quality of life					
	Social impacts					
Costs	Capital					
	Operating					
	Surface access					
Operational	Resilience					
	Efficiency (delay)					
	Reliability					
	Passenger experience					
	Safety					
	Scalability					
	Airspace					
Delivery	Timescales					
	Technical & operational risk					
	Planning risk					

ASSESSMENT RESULTS

Summary	The highlights of the core package currently include: • Support for the principle of increased information sharing between airport stakeholders and air traffic control through tools such as Airport Collaborative Decision Making, to enable the operational measures to achieve their full potential. • Support for ongoing industry initiatives, chiefly the Future Airspace Strategy and London Airspace Management Programme, aimed at optimising the airspace management for arrivals and departures, producing carbon savings and adding additional resilience into network-level air traffic control. • Further measures to enhance the resilience of Heathrow, such as a shift to time rather than distance based separations between aircraft and revisions to Standard Instrument Departure routes. • Support for the use of dedicated business airports (though not mandated through regulation, as the small amount of business traffic using Heathrow and Gatwick appears to have strong reasons to do so). • Trialling changes in the use of Heathrow's runways during the early morning period to allow for more flights in the 5-6am period in return for an end to the routine use of both runway runways between 6-7am therefore supporting the principle of respite.
Strategic fit	The core package would enhance the reliability and resilience of Heathrow Airport (primarily as it is the airport with the most serious resilience and reliability issues), reducing delays and cancellations for airlines and airline customers and increasing the overall quality of service to users. This would support Heathrow being a better airport, which would attract airline passengers because of the reliability of service and reduced delays. There would also be more modest improvements in resilience and reliability at other airports, particularly Gatwick. The package would also deliver some modest respite in noise. Whilst this package will result in savings in time for existing users of Heathrow and Gatwick (and operational savings for airlines at both airports), these benefits will still increasingly be offset by higher fares due to demand continuing to be constrained by the ability of airlines to supply capacity within the movement caps and the inability of new market entry to be established at either Heathrow or Gatwick. This may reduce connectivity over the longer term, as it will result in airlines focusing use of existing capacity on highest yielding services, which may see a continuing trend of reduced domestic and short-haul services, and increased frequencies on established long-haul routes.
Economy	Net NPV of **£2.6B** (2014-2030) compared with the status quo[1], of which **£1.5B** is attributed to airlines, **£0.6B** to airline customers, a further **£0.3B** from liberalisation of air services agreements and **£0.2B** from reduced cancellation costs. These benefits are largely due to reduced airline operating costs and reduced delays and cancellations for airlines and airline passengers because of the implementation of operational freedoms, A-CDM (local and network), enroute arrival management, revised LVP triggers and changes to early morning arrival procedures. Incumbent airlines at Heathrow and Gatwick will see increases in the values of their existing slot pairs due to increased scarcity. The liberalisation of air services agreements with some countries, particularly to allow additional 5th freedom services is likely to make a modest contribution to reduced passenger costs and improved connectivity for the airports that gain such services.
Surface Transport	Negligible impacts.
Environment	Quantitative analysis indicates savings of approximately **7.12Mt** of CO_2 over the period 2014 to 2030, compared to *the status quo* based on 2008 operations and performance, extrapolated to 2030 taking into account forecast fleet changes. Based on CO_2 savings, and the price of in the central scenario of traded carbon prices savings are indicated over the period 2014 to 2030 of approximately **£147.9M NPV**. There are reductions in NOx emissions compared to the current situation. In terms of noise, the benefits / disbenefits result in an overall neutral impact although if modernisation of the fleet is allowed for, a positive outcome would be expected. Based on anticipated fleet mix changes, ERCD Report 0705[2]

[1] The 'status quo' means current operations using a baseline of 2008 data.

[2] Revised Future Aircraft Noise Exposure Estimates for Heathrow Airport
http://www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=4979

	suggests that 480,000 ATMs in segregated mode would, compared to 2002, see the 57dB Leq contour **reduce by approx. 50km^2** by 2030 and the number of people in that contour **reduce by 115,600**. From 2013, the reductions would be around 43km^2 and a reduction in affected population of around 120,000.
People	Improved efficiencies in the airline sector will make an incremental contribution to maintaining and growing the aviation sector in the UK. Longer term impacts of improved resilience and reliability of major airports will have an incremental effect upon perceptions of quality of connectivity, and may be beneficial for investment, trade and tourism with consequential increases in employment. There are issues with redistribution of noise, and earlier extension of the morning arrivals period, rather than growth in noise energy in total, but the nature of the changes will impact specific communities. The overall noise benefit is initially neutral but improves as aircraft get quieter.
Cost	Capital costs have been estimated at £20M, in addition to currently planned expenditure at airports. Operating costs have not yet been quantified.
Operational Viability	Many of the measures anticipated in the core package are already planned by airports, CAA, NATS and some airlines. Operational freedoms have already been trialled.
Delivery	Further work needed to allow for the introduction of time-based separations, enhanced low visibility operations, independent parallel approaches at Heathrow and reduced separation on SIDS. There are planning risks associated with permission to apply single runway operations for early morning arrivals and permission to apply operational freedoms.

ECONOMIC IMPACTS

Impact on Industry (summary commentary)

The primary impact on the aviation industry will be at airports operating close to full capacity on a regular basis, primarily Heathrow, but also Gatwick at peak times, with minor gains possible at other airports. Other measures have a wider application (e.g. wider liberalisation of 5th freedom traffic) to support growth in aviation across the UK. Heathrow Airport, and its airline and passenger customers, will see the greatest impact, primarily because existing resilience issues and the frequency and severity of delays are most critical at Heathrow. Some of these measures will also deliver worthwhile improvements for Gatwick Airport and its users, given it is expected that with growth it will increasingly experience more of the resilience issues that occur at Heathrow. These measures can also deliver network wide time and fuel savings benefiting the wider aviation sector, and its users. These measures will reduce operating costs for airlines and delays for airline customers, delivering net economic benefits of around **£2.6B (NPV)** by 2030 for the aviation sector and its users.

Airports	Heathrow Airport will benefit indirectly from its users having fewer cancellations and delays due to resilience issues, and so being likely to attract incremental increases in users due to improvements in the perceived quality of experience both as a point-to-point and as a transfer airport. Gatwick Airport may also gain some incremental benefits by the application of some of these measures. Other major UK airports may benefit from incremental additional traffic with liberalisation of 5th freedom traffic rights.
Airlines	The core package will deliver quantifiable airline cost savings (2014 to 2030) of: **£1.5B NPV** primarily due to reduced delays (higher efficiency) with lower fuel / crew costs. **£194M NPV** due to reduced cancellations (higher resilience) They will also deliver potential savings of order **£78M NPV** in reduced block-time buffers at Heathrow as flight delays reduce and flight times become more predictable. Efficiency measures will deliver delay reduction benefits at other airports during busy times, principally Gatwick. Some airlines will see incremental increases in business due to promotion of services to regional airports and the opportunities to introduce new 5th freedom services, although this may also have a marginal impact on airline competition on certain routes.
Passengers	Operational and resilience improvement measures will deliver quantifiable passenger cost savings (2014 to 2030) at Heathrow of **£579M NPV** due to reduced delays, with further qualitative improvements due to increased trip reliability and comfort due to reduced cancellations. These measures will also deliver benefits at other busy airports, principally Gatwick. Some passengers will also gain time and fare savings from the introduction of new 5th freedom services at regional airports.

DfT WebTAG Impacts (summary commentary)

- Economic Surplus Producers: **£1.7B NPV** in surplus due to improved efficiencies, reduced fuel consumption, reduced labour costs, reduced costs of cancellation and delay and improved resource allocation
- Economic Surplus Passengers: **£579M NPV** incremental benefits to passengers due to reduced travel times and reduced airfares due to increased efficiencies and more services due to 5th freedoms
- Time Savings From Delay Reduction: Included in passenger benefits above
- Public Accounts: Negligible impact on public accounts, likely to be positive due to incremental increases in demand.

• Wider Impacts And Regeneration: (See National Economic Impacts, Local & Regional Economic Impacts); • Surface Access Impacts: (See below domestic connectivity).	
User benefits	Reduced delays and cancellations; improved resilience; incremental increase in 5th freedom services at regional airports.
Externalities (e.g. noise & CO_2)	Based on CO_2 savings, and the price of in the central scenario of traded carbon cost[3] savings are indicated over the period 2014 to 2030 of approximately **£147.9M NPV**. Noise cost benefits have not been quantified. For LHR, consistent year-on-year increase as a worst case in out-of-alternation arrivals from 21 additional out-of-alternation arrivals per day in 2014 to 62 additional out-of-alternation arrivals per day in 2030 due to the expected increase in A380s at Heathrow.
Connectivity to domestic markets (summary commentary) Negligible impacts are expected, as continued capacity pressures will maintain pressure on airlines to choose whether to use scarce airport capacity for domestic or international services.	
International connectivity (interline vs. point-to-point; market access)	Liberalisation of 5th freedoms with some countries may result in a small number of incremental additional services at regional airports (i.e. assumed to be about 3 additional services daily by 2030 across the UK). However, increased pressure on airport capacity will continue to limit scope for airlines to add commercially viable routes and frequencies at Heathrow and Gatwick.
Domestic connectivity (surface transport & domestic aviation)	Negligible impacts are expected from measures that primarily support enhanced resilience and reliability of existing airports
National Economic Impacts (summary) Compared to the status quo, the core package will result in savings in operating costs for airlines and time-savings for passengers that will contribute to improved productivity. There will also be an incremental longer term improvement in perceptions of the quality of connectivity to the UK via Heathrow, because of improved resilience and trip reliability. However, the ability of these productivity improvements to translate into lower fares will remain limited due to demand continuing to exceed capacity at Heathrow. The introduction of new 5th freedom services at some regional airports is likely to contribute towards reduced costs for users of those services and enhanced connectivity for the cities served, creating (small) potential long term benefits in improved trade, tourism and investment.	
Local & Regional Economic Impacts (summary) • Support to trade: The core package will support additional services due to liberalised 5th freedom based air services agreements may catalyse improved trade and tourism in the UK regions. Longer term improvements to resilience and reliability at Heathrow are likely to support improved connectivity and support growth in demand, although it is likely that the airline response to this will be to increase the size of aircraft used (where viable) and increase fares. • Creation of new industries: Additional services due to liberalised 5th freedom based air services agreements may catalyse enhanced trade, investment and tourism to the cities served. • Land Impact: Negligible impact • Direct Employment: Additional services due to liberalised 5th freedom based air services agreements may catalyse additional trade, investment and tourism. Incremental improvements to airline productivity due to enhanced resilience and reduced delays will support marginal growth of airlines with UK based operations, although scope to increase employment for operations based at Heathrow will be negligible due to capacity constraints. • Indirect Employment: Negligible impacts due to improved productivity and liberalised 5th freedom services. • Induced Employment: Negligible impacts • Catalytic Employment: Negligible impacts • Agglomeration Impacts: Support for improved resilience in Heathrow Airport will support the agglomeration effects of industries currently supported by connectivity due to Heathrow. • Residual Value: Not relevant.	

[3] https://www.gov.uk/carbon-valuation

ENVIRONMENT

Noise

This package includes a large number of measures some of which will be of benefit in terms of noise reduction and others that will not. The benefits / disbenefits result in an overall neutral rating although if modernisation of the fleet is taken into account, a positive outcome would be expected. Based on anticipated fleet mix changes, ERCD Report 0705 suggested that 480,000 ATMs in segregated mode would, compared to 2002, see the 57dB Leq contour **reduce by approx. 50km^2** by 2030 and the number of people in that contour **reduce by 115,600**. From 2013, the reductions would be a reduced area impact of around 43km^2 but an increased reduction in population of around 120,000. The most significant potential benefit is the development of compensation / mitigation regimes for noise, although the full costs / benefits have not been modelled at this time. Some benefits may be expected from steeper approach angles, dependent on approach paths but the effect has not yet been modelled. Benefits are also expected in ground noise and from reduced stacking of aircraft although these form a relatively small part of the total noise produced. Countering these improvements would be the proposed removal of the westerly preference, which will lead to some communities experiencing increases in noise: in such a scenario ERCD Report 0705 would suggest that in the absence of the Cranford Agreement that there is little change in the overall contours from preference, but for the higher levels of noise exposure there are likely to be increases in affected population. A further potential negative impact might occur from spreading of the early morning arrivals further into the night period.

Local air quality

Quantitative analysis indicates savings of approximately **6850 tonnes** of NO_x at Heathrow over the period 2014 to 2030, compared to *the status quo* based on 2008 operations and performance, extrapolated to 2030 taking into account fleet changes. This is delivered by:

- reduction in separation between SIDs[4]: saving 165 tonnes per year, starting in 2016
- reduction in aircraft on ground emissions from reduced engine taxi[5]: saving 170 tonnes per year, starting in 2016; there will be reduced NO_x at other airports where similar procedures are implemented.
- local A-CDM[6]: saving 106 tonnes per year, starting in 2014.

Climate change

Quantitative analysis indicates savings of approximately **7.12 million tonnes** of CO_2 over the period 2014 to 2030[7], compared to *the status quo* situation based on 2008 operations and performance, extrapolated to 2030 taking into account fleet changes.

This is delivered at Heathrow by:

- en route arrival management[8]: 105,000 tonnes savings per year, starting in 2019
- time-based separations[9]: 58,000 tonnes savings per year, starting in 2019
- single runway for early morning arrivals[9]: 69,000 tonnes per year, starting in 2015
- reduction in separation between SIDs[4]: 40,500 tonnes per year, starting in 2016
- local A-CDM[6]: 26,000 tonnes per year, starting in 2014
- operational freedoms facilitate an increase in A380s in the fleet mix[9]: approximately 95,000 tonnes per year, from 2014.

There are likely to be further impacts on greenhouse gas emissions as follows:

- reduced engine taxi procedures across main airports could save 46,500 tonnes of CO_2 per year from 2016
- civil:military airspace optimisation will increase capacity, reducing delays, and allow flight-paths to be shortened. Both will reduce fuel burn and hence will reduce CO_2 emissions
- removal of westerly preference will result in a slightly higher proportion of operations in the easterly direction with a slight increase in the number of track miles flown, estimated to be 260,000 miles per year[10]. At a speed of 200 knots this equates to 1300 additional minutes of flying, estimated to generate an additional 100 tonnes of CO_2 per year.

At Gatwick, rough estimates indicate the following potential climate change impacts[11]:

- en route arrival management: 14,700 tonnes CO_2 savings per year starting in 2019

[4] LeighFisher analysis has estimated delay and NOx benefits from a relationship to CO_2, derived from estimates of fuel burn generated using the ground holding delay models developed in the CAA runway resilience study (http://www.caa.co.uk/docs/589/ICF_runway_resilience_final_report_16Feb09.pdf) augmented by emissions predictions generated using the ICAO Aircraft Engine Emissions Databank and the Eurocontrol BADA (Base of Aircraft DAta), http://www.eurocontrol.int/services/bada

[5] Reduced engine taxi benefits for NOx and CO_2 have been calculated from reference to BMI trial results at Heathrow (http://www.heathrowairport.com/about-us/community-and-environment/sustainability/case-studies/taxiing-the-way-to-lower-emissions), the estimate of ground level Aircraft NOx at Heathrow (http://www.heathrowairport.com/static/Heathrow/Downloads/PDF/air-quality-strategy_LHR.pdf) and apportioned to 50,000 ATMs based on CAA activity data for 2008. Sustainable Aviation CO_2 roadmap identified that taxiway availability would constrain any benefits from RET, so the approach here is conservative.

[6] Derived from fuel savings information provided by Heathrow Airport.

- reduction in separation of SIDs: approximately 20,000 tonnes CO_2 savings per year starting in 2016
- local A-CDM: approximately 13,000 tonnes CO_2 savings per year starting in 2014.

It is not possible to quantify all impacts at other airports but in particular: en route arrival management; reduction of separation between SIDs; and local A-CDM are likely to deliver reductions in CO_2 emissions at peak times. No significant CO_2 benefits are expected from airside vehicle changes (although these may support wide energy strategies), steepening of approaches (although NATS indicates some potential for optimising level flight segments which may see some incremental change).

PEOPLE

Employment

No significant impacts on employment are anticipated from deployment of the core package, although the support given to the aviation industry will reduce the likelihood of workforce reductions.

Improved efficiencies in the airline sector will make an incremental contribution to maintaining and growing the aviation sector in the UK. The longer term impacts of improved resilience and reliability of major airports will have an incremental effect upon perceptions of quality of connectivity, and may be beneficial for investment, trade and tourism with consequential increases in employment.

Introduction of new services due to liberalisation of 5th freedom traffic will create incremental new employment at airports where such services will operate to and from, and indirect employment arising from additional trade, tourism and investment due to passenger and cargo traffic attracted by such services.

Housing and demolitions

No housing demolitions will be required. The overall impact of 480,00ATMs under segregated mode operation is a significant reduction in the number of people within the 57db Leq contour.

The proposed removal of westerly preference at LHR will lead to some redistribution of noise: in such a scenario ERCD Report 0705 suggested that by 2030 the number of households (a proxy for properties) within the 57dB contour would reduce by 900 fewer than under westerly preference.

Number of Houses	
New	*Demolished*
nil	nil

Vulnerable groups

No significant impacts on vulnerable groups are anticipated from deployment of the core package, as noise impacts are anticipated to reduce over time, although re-distribution of noise may result in specific local impacts.

Quality of life

There will be a steady decrease in noise levels, reflecting the fleet mix. Some redistribution of noise will occur. At Heathrow, application of operational freedoms to manage the increase in the proportion of A380s in the fleet mix will result in an increase in the number of de-alternated flights, compared to a baseline. This would be managed using conventional TEAM. Therefore there will be a general reduction in respite after 07:00 hours. The increase in de-alternated flights would range from approximately 15 per day in 2014 up to 62 per day in 2030, giving an average over the period of 32 additional de-alternated flights per day (the current average is approximately 21 per day[12]. In addition, the use of a single runway for arrivals between 05:00 and 07:00 will result in an increase in arrivals between 05:00 and 06:00 of, on average approximately 15 arrivals (the actual figure would depend on the schedule), a decrease on arrivals between 06:00 and 07:00 of approximately 8 arrivals (again the actual figure would depend on the schedule). However, alternation and respite would be more likely, with 06:00 to 07:00 de-alternation being reduced by approximately 22 arrivals per day.

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7 Carbon impact calculated from estimated fuel savings, using emission factor for Jet A1: http://www.ukconversionfactorscarbonsmart.co.uk/

8 Derived from: Feasibility and options for reducing airborne holding for Heathrow arrivals, Helios report, P1480D005 v1.0 dated 30 June 2011, produced under contract 1387 jointly sponsored by CAA and NATS

9 LeighFisher analysis has estimated arrival delay and CO_2 emissions using the airborne holding delay models developed in the CAA runway resilience study (http://www.caa.co.uk/docs/589/ICF_runway_resilience_final_report_16Feb09.pdf) augmented by emissions predictions generated using the ICAO Aircraft Engine Emissions Databank and the Eurocontrol BADA (Base of Aircraft DAta), http://www.eurocontrol.int/services/bada

10 London Heathrow Airport westerly preference study, stage 2 analysis, v1.0, NATS, 28 June 2013

11 Scaled from Heathrow figures using the ratio of delays described in the 2008 CAA runway resilience report, http://www.caa.co.uk/docs/589/ICF_runway_resilience_final_report_16Feb09.pdf

12 http://www.heathrowairport.com/static/Heathrow_Noise/Downloads/PDF/Heathrow_Operational_Freedoms_trial-Phase_1-report.pdf

The incremental improvement in reliability and resilience at Heathrow will result in fewer cancellations and delays of flights, improving the travel experience of passenger who otherwise will have had to reorganise business and leisure trips and associated activities, and endure the stress of disruption to plans.

Social impacts
No additional social impacts compared to those indicated under the above sections are anticipated.

COST

Capital
Small (£20M)

- A-CDM: Already committed by Heathrow and Gatwick
- Civil/military airspace optimisation
- Creation of a known surveillance environment within a defined airspace: Mode S transponder costs estimated at £1,500 - £1,800 per aircraft.
- Electric / low emission vehicles airside will have an additional capital cost over 'traditional' vehicles
- Marketing UK regional airports as destinations will impose a low (<£100k) per annum cost on the existing tourism promotional budget of the British Tourist Authority

Operating
Operating costs are expected for the following measures:

- A-CDM
- Enroute arrival management
- Local capacity management cells. This also imposes costs on airlines affected by cancellation, partly offset by avoided cancellation and delays for other flights
- Reduced engine taxi-in should produce incremental fuel savings for airlines
- Review of triggers on the application of Low Visibility Procedures
- Review of TBS/Weight Vortex Separations
- Operational Freedoms for resilience
- Removal of Westerly Preference/alternation regime on easterlies
- Multiple arrival routes for respite
- use of single runway for early morning arrivals (likely to produce modest operational cost savings for airlines at that time)
- Steeper approaches
- Independent parallel approaches to Heathrow
- Dual approaches to a single runway at Gatwick
- Reduction in separation between SIDS
- Introduction of the reliever airports concept

Mitigation and compensation
Unknown at this stage.

Surface access
To be considered separately.

OPERATIONAL IMPACT

Resilience

At Heathrow, resilience measures (forming part of the Airport's Airfield Operational Efficiency Programme) are forecast to deliver savings in cancellations[13] of **£201M** NPV from 2014 to 2030. The 2008 CAA runway resilience study showed that Heathrow is far more prone to large-scale cancellations than other airports, due to its mode of operation and very high utilisation. Resilience measures will likely have much more impact at Heathrow than at other airports. The Heathrow resilience savings will be delivered by:

- local A-CDM: delivering a saving of approximately 200 cancellations per year, equating to a cost saving of approximately £6M per year
- enhanced low visibility procedures: delivering a saving of approximately 600 cancellations per year, equating to a cost saving of approximately £11M per year.

In addition to these quantitative savings, the local capacity management cell (HADACAB) at Heathrow is enhancing recovery from adverse conditions. Similar cells might also be beneficial at managing the response to and recovery from adverse conditions at other busy airports.

In addition there will be positive impacts on resilience from:

- network level A-CDM will contribute to the optimisation of the European air traffic management network[14] estimated to deliver an overall capacity increase of 0.5% (with cost savings to air traffic in the UK of around £19M/year)
- enhanced information exchange between airspace and smaller airports that will enable more accurate planning to minimise the risk of capacity shortfalls and ameliorate delays and disruption due to airspace;
- defining known surveillance environments for specific airspace by requiring all aircraft within such space to carry transponders to avoid infringements and unknown tracks that can disrupt operations.

Efficiency

At Heathrow, efficiency initiatives are likely to deliver savings in delays to airlines[15] of **£1.5B** NPV from 2014 to 2030 and savings in delays to passengers of **£599M NPV** from 2014 to 2030 compared to *the status quo* based on 2008 operations and performance, extrapolated to 2030 taking into account forecast fleet changes. This is delivered by:

- en route arrival management[16]: £22M savings/year (airlines) based on fuel savings, starting in 2019
- time-based separations[17]: £12M savings/year (airlines) and £5M savings/year (passengers), starting in 2019
- single runway for early morning arrivals[9]: £11M savings/year (airlines) and £5M savings/year (passengers) from 2015
- reduction in separation between SIDs[18]: £17M savings/year (airlines) and £12M savings/year (passengers) from 2016
- local A-CDM[19]: £11M savings per year to airlines and £7M savings to passengers per year, starting in 2014
- operational freedoms to facilitate the increase in A380s in the fleet mix[9]: an average of £48M savings per year to airlines and £21M savings to passengers per year, starting in 2014.

At Gatwick, rough estimates indicate the following potential efficiency impacts[20]:

- en route arrival management: approximately £3M savings/year (airlines) based on fuel savings, starting in 2019
- reduction in separation of SIDs: approximately £8M savings/year (airlines) and £6M savings/year (passengers) from 2016
- local A-CDM: approximately £6M savings/year (airlines) and £4M savings/year (passengers) from 2014
- dual approaches to a single runway: would potentially increase the runway throughput at busy times, reducing associated delays.

It is not possible to quantify impacts at other airports but in particular: en route arrival management; reduction of separation between SIDs; and local A-CDM are likely to deliver reductions in delays at peak times.

In addition there could be positive impacts on efficiency and reduced delays from:

- operation to an optimised daily service plan that will match on the day demand to on the day capacity
- incentivisation of arrival punctuality, that will remove the current perverse incentives to arrive early, reduced bunching at pinch points at busy times and reduce delays associated with that bunching
- network level A-CDM that will contribute to the optimisation of the European air traffic management network estimated to deliver an overall capacity increase of 0.5%
- enhanced information exchange between airspace and smaller airports that will enable more accurate planning to minimise the risk of capacity shortfalls and ameliorate delays
- Optimisation of the use of civil and military airspace to facilitate more direct routings for airline traffic at locations and times that will not disrupt military operations.

[13] Derived from fuel savings information provided by Heathrow Airport.

[14] Eurocontrol Experimental Centre, Airport CDM, cost benefit analysis, report 2005, EEC note no. 18/05, September 2005

Reliability

Based on reduced delay and enhanced resilience at Heathrow and associated airspace; and measures such as operation to an optimised daily service plan and; incentivisation of arrival punctuality; airlines would be expected to be able to reduce the buffers in their Heathrow schedules[21]. These are currently necessary to ensure reasonable punctuality against uncertain levels of delay. It is estimate that these savings in block-time buffers could amount to a reduced cost to airlines of **£78M NPV** from 2014 to 2030.

Similar levels of buffer are not likely to be applied at other airports so this benefit is likely to be restricted to Heathrow.

Passenger Experience

Qualitatively the passenger experience will be improved through:

- reduced airborne holding at Heathrow and Gatwick due to en route arrival management
- reduced ground holding at Heathrow and Gatwick due to local A-CDM and reduction in separation between SIDs
- reduced airborne holding at Heathrow due to: use of a single runway for early morning arrivals; time-based separations during windy conditions
- use of operational freedoms to facilitate the increase in A380s in the fleet mix.

Passenger experience will also be enhanced during adverse conditions due to local capacity management cells that will deliver more certainty concerning cancellations and provide information to allow passengers to plan ahead.

The introduction of additional 5th freedom services could provide additional destinations, routing and airline options for some passengers, which is likely to offer travel time and fare savings for users of such services.

Safety

There is likely to be a small reduction in risk delivered through the creation of a known-surveillance environment. This risk reduction will arise through better knowledge of the location of light aircraft, especially near to airports outside of controlled airspace, allowing remedial action to be taken if infringements occur.

Other measures will need to be the subject of safety cases.

Scalability

The package is not easily scalable.

Airspace

Some airspace redesign will be needed but is being addressed through the LAMP and FAS programmes.

15 Delays are derived from modelling and are then monetised using values derived from: Standard inputs for Eurocontrol cost benefit analyses, edition 5.0, December 2011.

16 Derived from: Feasibility and options for reducing airborne holding for Heathrow arrivals, Helios report, P1480D005 v1.0 dated 30 June 2011, produced under contract 1387 jointly sponsored by CAA and NATS

17 LeighFisher analysis has estimated arrival delay and CO_2 emissions using using the airborne holding delay models developed in the CAA runway resilience study (http://www.caa.co.uk/docs/589/ICF_runway_resilience_final_report_16Feb09.pdf) augmented by emissions predictions generated using the ICAO Aircraft Engine Emissions Databank and the Eurocontrol BADA (Base of Aircraft DAta), http://www.eurocontrol.int/services/bada

18 LeighFisher analysis has estimated delay and NOx benefits from a relationship to CO_2, derived from estimates of fuel burn generated using the ground holding delay models developed in the CAA runway resilience study (http://www.caa.co.uk/docs/589/ICF_runway_resilience_final_report_16Feb09.pdf) augmented by emissions predictions generated using the ICAO Aircraft Engine Emissions Databank and the Eurocontrol BADA (Base of Aircraft DAta), http://www.eurocontrol.int/services/bada

19 Derived from fuel savings information provided by Heathrow Airport

20 Scaled from Heathrow figures using the ratio of delays described in the 2008 CAA runway resilience report, http://www.caa.co.uk/docs/589/ICF_runway_resilience_final_report_16Feb09.pdf

21 Based on the observations on the extension of short-haul block-times reported in the CAA runway resilience study (http://www.caa.co.uk/docs/589/ICF_runway_resilience_final_report_16Feb09.pdf)

DELIVERY

Timescale

The measures would be delivered in phases starting in 2014 and the complete package would be delivered by 2019.

Technical and operational risks

The principal technical and operational risks are:

- safety cases for time-based separations; enhanced low visibility operations; independent parallel approaches at Heathrow, dual approaches to a single runway at Gatwick and reduced separation on SIDs
- technical feasibility of improved weather forecasts needed for enhanced low visibility operations, specifically the triggers for the application of LVP, dual approaches to a single runway at Gatwick.

Planning risk

There is planning risk associated with:

- permission to apply single runway operations for early morning arrivals that will increase the number of movements in the night quota period. This change in operations would also be subject to agreement from the Department for Transport's Secretary of State as it would necessitate a change in the night noise regulations
- permission to apply operational freedoms
- the redesign of SIDs needed to enable reduced separation between SIDs. Any changes to SIDs need permission from the CAA and in some cases from the Department for Transport's Secretary of State
- success of bilateral negotiations to liberalise air services agreements with other countries, particularly in allowing 5th freedoms
- commercial interest of airlines in introducing new 5th freedom services
- other countries' interests in accepting more liberal air services agreements with the UK to allow for the establishment of 5th freedoms to regional airports.

Package: 0	Core package of short term measures		

MEASURES INCLUDED IN THE PACKAGE

Group	Measure	Description	Template ref.
Airspace ops	Network level A-CDM	A-CDM aims at improving airport and network operations via means of enhanced communication and information sharing between airport stakeholders. There are two levels of implementation of A-CDM: local and network; this proposal is concerned with the network implementation that comes after local implementation (see proposal ApOP-GOI-1 for the local implementation of A-CDM). The network implementation would feed accurate departure information (departure planning information – DPI) into network and airspace capacity tools in real-time	ApOP-INM-1
	Implementation of major programmes, including SES/SESAR, FAS, LAMP and the more specific airspace changes that underpin them	SES/SESAR, FAS and LAMP will deliver major changes to the operation of UK airspace, such as airspace structures, communications, (performance-based) navigation, surveillance and more flexible air traffic management to deliver benefits in terms of safety, capacity and environmental impact. These programmes are likely to deliver in the medium-term; however, there are initiatives being undertaken under their frameworks, such as proposals to redesign LHR departure routes, that might deliver in the short-term	AsOP-ASR-1
	En route arrival management	Arrival queue management would sequence access to runways earlier in the flight path, reducing the need for localised holding in stacks or extended approach paths. A phased approach delivering some benefits in the short-term but with the majority of benefits arising in the medium term. Proposal could be enhanced by applying incentives to align airline behaviours with desired outcomes.	AsOP-ARM-1
	Civil/military airspace optimisation	Civil/military airspace optimisation is about reprioritising access to airspace to the benefit of civil operations	AsOP-ASR-2
	Creation of a known-surveillance environment	Creation of a known-surveillance environment will define volumes of airspace within which all aircraft must carry transponders to avoid infringements and unknown tracks that can disrupt operations at major airports.	AsOP-ASR-3
	Optimisation of departure separation using advanced aircraft capability	Optimised departure separation enabled through use of advanced aircraft navigation capability: this is effectively the creation of new departure routes with less than the current spacing and potentially down to less than the current 15° minimum standard (see for example trial results at Atlanta Airport).	AsOP-DPM-1
	Distributing departure routes within noise preferential route (NPR) swaths	Distributing departure routes within NPR swaths principally for respite but potentially also for resilience (Heathrow and Gatwick).	AsOP-DPM-3
	Incentivisation of arrival punctuality	Focus on arrival punctuality will realign incentives for flights to arrive rather than depart within a more predictable time window, reducing arrivals bunching and smooth arrivals flows, thereby reducing stack	AsOP-RCH -2

		holding and optimising the use of terminal airspace.	
	Review of triggers for application of LVP	Applying triggers for the application of LVP differentiating between low visibility (fog and mist) and low cloud ceiling will ensure that the capacity constraints associated with LVP will only be enacted when absolutely necessary thereby increasing resilience.	AsOP-RCH -3
	Enhanced information exchange between airspace and airports	This measure would support the implementation of simple interfaces for electronic data exchange between smaller airports and the air traffic management network to ensure air traffic managers across the network have as complete a picture as possible of current and near term operations.	ApOP-INM-2
Airport ops	Local- A-CDM	A-CDM aims at improving airport operations via means of enhanced communication and information sharing between airport stakeholders. There are two levels of implementation of A-CDM: local and network; this proposal is concerned with the local implementation.	ApOP-GOI-1
	Reduced engine taxi	This would involve aircraft taxiing to and from the runway using a reduced number of engines. This has the potential to reduce fuel burn and therefore emissions such as carbon dioxide and nitrogen oxides.	ApOP-GOI-2
	Use of electric vehicles airside	This supports the use of electric vehicles for airside operations to decrease the emissions associated with ground operations.	ApOP-GOI-3
	Local capacity management cell	National and local capacity management cells would improve decision making concerning modifications to the schedule to mitigate the potential impacts of disruption and to facilitate recovery from disruption. This process is already implemented at Heathrow as HADACAB.	ApOP-INM-3
	Steeper approaches	Using steeper approaches (descent angle increased from 3° to 3.25° or 3.5° depending on aircraft capability and safety cases) to increase the height of aircraft on final approach at given distances from the threshold, with the potential to reduce noise.	AsOP-ARM-3
	Time-based separations	Weather disruption management to include amelioration of the impact of high winds (principally at LHR and LGW) through application of time-based separation (TBS).	AsOP-ARM-2 / AsOP-RCH-1
	Operational freedoms	The operational freedoms measure comprises four proposals to introduce more flexible use of the runways and departure routes at Heathrow: • allocating arrivals to the departure runway as needed to improve overall efficiency (TEAM) • vectoring of departures from the SID centreline to maximise departure capability • allocating departures to the arrivals runway to improve overall efficiency as circumstance allow (TED) • tactical use of the southern runway for T4 and A380 arrivals. All of these proposals have the potential to be enacted in the short-term.	ApOP-HOF-1 ApOP-HOF -2 ApOP-HOF -3 ApOP-HOF-4
	Single runway for early morning arrivals	To enable the use of a single runway for arrivals at Heathrow between 05:00 hours and 07:00 instead of the two runways that are routinely used between 06:00 and 07:00, the proposal is to open the airport earlier to spread the early arrivals over two hours instead of one to guarantee use the single runway for arrivals. This would provide respite under the approach path of one runway but mean that noise under	ApOP-HPC-5

		the other flight path would be increased and be more intense earlier in the morning. It is assumed (not stated in the proposal) that the alternation pattern would apply from 05:00 hours.	
	Independent parallel approaches at LHR	Enabling independent parallel approaches at LHR to allow simultaneous, rather than offset, landings on both runways to maximise arrival throughput, when both runways are in use for arrivals.	AsOP-ARM-6
	Removal of the westerly preference	For removal of westerly preference, the tailwind threshold of >5knots would be replaced by a decision based simply on wind direction, thereby reducing slightly the proportion of time that the airport operates towards the west	ApOP-HPC-2
	Application of an alternation regime on easterlies	For easterly alternation, a pattern similar to that currently applied on westerly operations would be utilised. This would mean that the runways used for arrivals and departures would be swapped at 15:00 hours following a similar pattern to that applied on westerly operations. In this way both runways at Heathrow could be fully alternated.	ApOP-HPC-1
Slot/scheduling reform	Operation to an optimised daily service plan	To produce, ensures compliance with and deliver an optimal on-the-day arrival and departure schedule based on accurate predictions of runway throughput rates.	SSR-DMA-3
New service concepts	Service prioritisation	Currently queues of aircraft are managed on a first-come, first-served basis. This can sometimes result in behaviours which are detrimental to the performance of the systems as a whole, e.g. in incentivising flights to be at the front of the queue, for example when an airport opens after the night period or after periods of disruption. This can cause bunching and increased aircraft queue lengths on arrival particularly at busy airports like Heathrow. This measure would result in the application of the most appropriate method of aircraft queue management, selected from 'first come first served' (as at present), 'on-time, first-served' (where priority is given to flights that are on-time) or best equipped, best served (where priority would be given to the most capable aircraft).	AsOP-NSC-1 AsOP-NSC-2 AsOP-NSC-3 AsOP-NSC-4
Airservices agreements	Fifth freedom rights	Granting Fifth Freedom rights through LGW, LTN and/or STN as well as regional airports Granting Fifth and Eighth Freedom rights with LHR as the intermediate airport.	ASA-B&B-1 ASA-B&B-3
Financial incentives	Marketing regional airports as destinations	Marketing (Fly Local campaigns) and financial incentivisation to encourage use of regional airports, reflecting that much demand at London airports, and particularly LHR starts in the regions that are themselves served by more local airports	FInc-RDEF-3

	Reliever airport concept	Business aircraft and general aviation would redirected away from Heathrow and Gatwick and towards smaller London/South East airports implemented through instruments mandating it or via softer incentives.	
	Tactical use of Northolt for domestic connectivity	This measure would see incentives for a relatively small number of flights, primarily those serving UK regions, to use Northolt and connect to Heathrow via a bus/coach based service.	
Enhanced mitigation	Compensation packages	Extension / standardisation of provision of compensation for households affected by negative environmental impacts.	EMit-PAC-2
	Incentivise quieter aircraft	This measure would see quieter aircraft being incentivised through a variable landing charge regime which saw louder aircraft being charged higher landing charges than quieter aircraft.	

ASSUMPTIONS

Measure	Approach and assumptions
En route arrival management	Starts 2019. Assumes linear holding can absorb 2 to 3 minutes of stack holding. Modified stack holding is calculated from operational data by subtracting the linear hold from each flight's stack hold and averaging over summer and winter seasons to give an average reduction in stackholding. Assumes that there is no time saving because the queue is shifted upstream. Assumes that there is a saving in CO_2 emissions driven by the reduction in average stack holding time with the multiplier derived from the analysis underpinning the Helios airborne holding report (reference**:** Feasibility and options for reducing airborne holding for Heathrow arrival, Helios, 30 June 2012 produced under contract 1387 (Helios) service order number 20, commissioned jointly by CAA and NATS). Gives a lower bound of the CO_2 saving because it omits the saving from the en route phase of flight arising because of s slower cruise speed, even though the flight is 2 to 3 minutes longer. Calculation is limited to Heathrow flights even though benefits likely to accrue at other airports during busy arrival periods. Simple scaling is possible for Gatwick based on the 2008 runway resilience report that shows airborne holding delays at LGW are 16% of those at LHR in summer and 7% in winter. Averaged this gives a yearly average of 14% - assumes that en route arrival management delivers 14% of the benefits at Gatwick that it delivers at Heathrow. Calculation limited to Heathrow and Gatwick even though benefits likely to accrue at other airports during busy arrival periods.
Time based separations	Starts 2019. Assumes that TBS delivers increased arrival flows during high (20 knots at 3000ft) headwind conditions (reference operational freedoms trigger condition). Assumes that this condition is met 20% of the time in summer and 36% of the time in winter. TBS adds 2 to 4 arrivals per hour during very high headwind conditions (source: NATS). Half this increase is assumed as a baseline. Benefits calculated in terms of reduced stackholding using the models developed for the CAA runway resilience study that includes the impact of strong winds for the day from 08:00 onwards (assumes that pre-08:00 is dealt with through TEAM which is applied virtually every day from 06:00 to 08:-00. This impact is neutralised by adding back TBS capacity scaled in proportion to the likely occurrence of strong winds (2 to 4x0.20 for summer and 2-4x0.35 in winter).
Single runway for early morning arrivals	Starts 2015. Scenario 1 assumes that the demand profile from 05:00 to 06:59 is smoothed over those two hours; scenario 2 assumes that the demand profile from 05:00 to 07:59 is smoothed over those three hours . With the statistical models as currently established the modelling resolution is one hour – so it is not possible to look at the schedule in more detail. Single runway arrivals are assumed for 05:00 to 07:00.
Independent parallel approaches at Heathrow	Enables more efficient use of TEAM. Assumes that this only has an impact on the 06:00 hour when TEAM is applied such that both runways are used equally as opposed to other times of the day when fewer than 6 arrivals can landed on the departure runway. Currently around 22 aircraft are landed on each runway between 06:00 and 07:00 – assumes that independent use of runways can accommodate up to 30 aircraft on each runway, i.e. a 36% capacity increase. **Note:** the benefits of this measure are exclusive with the benefits of use of a single runway for early morning arrivals, which negates the need for improved TEAM efficiency.
Reduction in separation between SIDs	Starts 2016. Assume 10 to 15% increase in departure capacity due to reduced separation between SIDs achieved either by PBN/RNAV capabilities or through controller vectoring. The impacts of this are calculated using the Heathrow delay curve models for time and CO_2 savings. CO_2 saving is translated into a fuel saving (1 tonne of fuel -= 3.149 tonnes of CO_2) and then translated into NOx (1 tonne of fuel = 12.8kg of NOx) The 2008 runway resilience report shows a very similar average ground holding delay at Gatwick compared to Heathrow. The total delays therefore scale according to traffic (assumed to be 2:1 resulting in departure benefits at Gatwick that are 50% of those at Heathrow).
Local A-CDM	Starts 2014. Assumes A-CDM and other process improvements deliver (source: Information provided by Heathrow Airport) the following at LHR: - reduction in departure holding of 1.5 minutes per flight (assumed also to apply at Gatwick and scales from Heathrow results on a 2:1 basis, as explained above) - avoidance of 200 cancellations per year.
Operational freedoms	Starts 2014. Assume that the availability of operational freedoms is used to overcome the negative capacity impact of increasing numbers of A380s (21 arrivals in 2014 (3%), 30 arrivals per day in 2016 (4.5%), 62 arrivals in 2030 (5.5%)) (Source: NATS). The Helios airborne holding report (**reference:** Feasibility and options for reducing airborne holding for Heathrow arrival, Helios, 30 June 2012 produced under contract 1387 (Helios) service order number 20, commissioned jointly by CAA and NATS) is used to compare the difference in delay using a 20 minute trigger for TEAM with the

	assumption that all A380s are landed on the departure runway (i.e. no negative impact on capacity). This difference is assumed to be the sole quantifiable benefit of operational freedoms based on the results of the recent trial. The negative impact on departures is calculated by adding the A380 arrivals to the departure runway loading taking account of the additional capacity gained through reduction in separation of SIDs
LVP	Starts 2014. Information provided by Heathrow Airport suggests that improved LVP procedures could result in 600 fewer cancellations per year split at a ratio of 70:30 long haul:short haul.
Block time reduction	Starts 2019. The 2008 runway resilience study shows an increase in block time of short haul flights to LHR of up to 18 minutes over 20 years. It is assumed that increases in reliability/resilience will reverse this increase by 50% over a period of 10 years, starting in 2019. Eurocontrol standard figures for strategic delays are used to calculate the associated benefit of this.
Steeper Approaches	Written evidence submitted by NATS to the Transport Committee in February 2013 indicated that there were noise benefits of steeper approaches in terms of SEL exposure. Impacts on the population around any given airport will need more detailed modelling. The same evidence indicated that although there were fuel burn reductions from steeper approach segments, the increased level flight segments tended saw overall emissions at a similar level to, or increased above the standard 3 degree approach. Ref: http://www.publications.parliament.uk/pa/cm201314/cmselect/cmtran/78/78we26.htm
Reduced Engine Taxi	Starts 2016. Has been derived from results of Heathrow BMI trial, which showed a reduction in CO_2 emissions of between 19-36% for taxi in and 7-35% for taxi out, with NO_x reductions of 16-35% and 7-34% reductions respectively. Sustainable Aviation's CO_2 road map comments that savings may be available from reduced engine taxi, but "that there remain some uncertainties surrounding the potential impact on taxiway capacity arising from significant deployment of reduced engine taxiing so the benefit may be limited. It has been included at LHR and other airports for this package of short term options and for scenarios 2 and 4, but excluded for Heathrow in scenarios 1, 3 and 5 for reasons on increased capacity / reduced taxiway availability in line with the issues identified by SA. The nominal benefit has been estimated from Heathrow reported / estimated CO_2 and NO_x emissions from 2008 applied to the number of movements. A conservative 5% reduction of 50,000 ATMs only has been used. 50,000 ATMs was just over 10% of LHRs ATMs in 2008 and just under 2% of UK ATMs, so is considered an indicative, but conservative saving. NO_x benefits have been estimated based on LHR published estimates of NO_x in 2008 of 5,800 tonnes, with 2,600 tonnes from ground. Actual benefits will vary according to where the practices are enabled, taxi distances and fleet mixes at a given airport, but nominal benefits have been identified to show distinction between opportunities afforded by the different packages. Ref: http://www.heathrowairport.com/static/Heathrow/Downloads/PDF/air-quality-strategy_LHR.pdf
Noise Impacts	Have been assessed on a qualitative basis. For quantification, cross reference has been made to ERCD Report: 0705 Revised Future Aircraft Noise Exposure Estimates for Heathrow Airport. Further detailed modelling may be appropriate to estimate the precise impact of the combination of measures within the packages.
Carbon Costs	Have been estimated using traded carbon prices, on the assumption that issues with the Aviation EU-ETS will be addressed. Carbon costs have been calculated at Low, Central and High scenarios, using DECC short term (to 2030) Carbon price forecasts from October 2012. Central scenario values only are presented, both as cumulative values and NPV, using Green Book deflationary factor of 3.5%. Ref: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/41794/6667-update-short-term-traded-carbon-values-for-uk-publ.pdf

Package: 0	Core package of short term measures		

Quantitative assessment for resilience - results

Item	Costs	Annual benefits/savings		
		Low	Med.	High
En-route arrival management	£6M (ref: NATS)	70ktonnes CO2 saving. Fuel cost saving: £15M	105ktonnes CO2 saving Fuel cost saving: £22M	135ktonnes CO2 Fuel cost saving: £29M
Time based separations	£13M (ref: NATS)	41ktonnes CO2 saving Total aircraft operating cost saving:£8.6M Pax opportunity cost saving: £4.1M	58ktonnes CO2 saving Total aircraft operating cost saving:£12.1M Pax opportunity cost saving: £4.9M	72ktonnes CO2 saving Total aircraft operating cost saving:£14.9M Pax opportunity cost saving: £7.2M
Early morning arrivals on single runway	Small	55ktonnes CO2 saving Total aircraft operating cost saving:£8.5M Pax opportunity cost saving: £4.1M		83ktonnes CO2 saving Total aircraft operating cost saving:£13.6M Pax opportunity cost saving: £6.6M
Independent parallel approaches at LHR	TBD		51ktonnes CO2 saving Total aircraft operating cost saving:£9.0M Pax opportunity cost saving: £4.3M	
Reduction in separation between SIDs	£500k (source: NATS)	34ktonnes CO2 saving 138 tonnes NOx savings Total aircraft operating cost saving:£14.7M Pax opportunity cost saving: £10.0M		47ktonnes CO2 saving 191 tonnes NOx savings Total aircraft operating cost saving:£20.1M Pax opportunity cost saving: £13.8M
Local A-CDM	Sunk		26ktonnes CO2 saving 106 tonnes NOx savings Total aircraft operating cost saving:£10.9M Pax opportunity cost saving: £7.4M. Avoided cancellations: £6.3M	
Operational freedoms to reduce impact of A380s (2014)	Small cost 15 additional de-alternated flights per day		68ktonnes CO2 saving Total aircraft operating cost saving:£44M Pax opportunity cost saving: £19M.	

Operational freedoms to reduce impact of A380s (2016)	Small cost 20 additional de-alternated flights per day		93ktonnes CO2 saving Total aircraft operating cost saving:£49M Pax opportunity cost saving: £21M.	
Operational freedoms to reduce impact of A380s (2030)	Small cost 48 additional de-alternated flights per day		104ktonnes CO2 saving Total aircraft operating cost saving:£49M Pax opportunity cost saving: £21M.	
Improved LVP processes: triggers for application; and increased flow rates with MLS			Avoided cancellations: £11M	