MAYOR OF LONDON

Transport for London

<u>Inner Thames Estuary Feasibility Study</u>

Response to Airports Commission Call for Evidence

The Mayor of London's Submission:
Supporting technical documents

23 May 2014

Title: **Potential Airspace Impacts of a New Hub Airport**

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Purpose of paper: **To present information and facts as to how it is possible to design and operate London's airspace to handle the air traffic demand forecast up to and beyond 2050.**

Key messages:

- It is possible to design and implement a safe, efficient and environmentally optimised airspace structure to support a new airport on the Isle of Grain that will take full account of the forecast demand and of existing airports in London and the near continent.
- We already have the necessary airspace regulations, technologies, procedures and agencies in use today, or planned, in the UK to cope with forecast demand.
- The future airspace configuration for London will require long term planning, necessarily complex design, extensive consultation, testing and a robust transition plan, irrespective of where new runways are built.

Mayor's Aviation Works Programme - New Hub Airport

Technical Note – Potential airspace impacts of a new hub airport

Transport for London

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Plan Design Enable

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Summary

- **Airspace implications of a new inner Thames Estuary Hub**
  - It is possible to design and implement a safe, efficient and environmentally optimised airspace structure to support a new airport on the Isle of Grain that will take full account of the forecast demand and existing airports in London and the near continent. We already have the necessary regulations, technologies and procedures either in use today or planned in the UK.
  - The future airspace configuration for London will require long term planning, necessarily complex design, extensive consultation, testing and a robust transition, irrespective of where new runways are built. The scope and capability exists to develop an optimised airport and airspace infrastructure, incorporating an inner Thames Estuary airport, without the need for arbitrary airport closures elsewhere.
  - Regardless of any future runway decision, at the UK national level, the CAA has published a Future Airspace Strategy Plan (FAS) to deliver airspace capacity needs forecast to 2025. FAS will deliver a fundamentally more efficient route network in the busy London airspace.
  - The airspace process is complex; it has many risks and variables. It is highly impacted by the actual growth of the number of flights, but NATS will be able to adapt and deliver the airspace solutions necessary to support new runways wherever they are built, the impact on other airports cannot be definitively assessed without more concrete information.
- **Observations on the Commission's work to date**
  - There is no clear basis that can be derived from the advice to the Airports Commission, or from separate airspace analysis, which supports the Commission conclusion that when IoG is opened, operational or airspace factors will require the closure of Heathrow, London City or Southend airports.
  - The Commission work has considered the maximum number of ATM achievable for any given runway option. There appears to have been no consideration of the optimum number of ATM each option, necessary to ensure a sustained reliable airport operation and efficient airspace infrastructure.
  - The IATA Airport Design Manual suggests a realistic design runway utilisation of 70%. Delays inherent to airport operations with very high runway utilisation will cause extended flight routings, aircraft holding and flight cancelations. The resulting airspace congestion of the 92% runway utilisation seen at Heathrow today, when its operations are disrupted, extends across the UK and into Europe.
  - More detailed work on the achievable optimum runway capacity for each airport option is needed, together with a clear understanding of the operational consequences and resilience of very high runway utilisation.

1. Introduction

This document presents information and facts as to why it is possible to design and operate the London airspace to handle the air traffic demand forecast up to and beyond 2050. The second section looks at the strategic aspects of re-designing the airspace, whilst the third considers it from a more tactical stand point. Finally section 4 presents a number of questions that all long term options being considered by the Airport Commission should be assessed against.

It is possible to design and implement a safe, efficient and environmentally optimised airspace structure to support a new airport on the Isle of Grain that will take full account of the forecast demand and existing airports in London and the near continent. We already have the necessary regulations, technologies and procedures either in use today or planned in the UK. Airspace in the UK is integrated into the homogenous Single European Sky.

The concepts, techniques and procedures used at airports in London, the nearby hubs in Schiphol, Paris and Brussels are either already, or will be consistent, harmonised and integrated, current programmes are converging any existing irregularities. The systems used on board aircraft and by pilots are also similarly interoperable. The Single European Sky legislation and resulting programmes begun in 2004, together with the global ICAO policy, secures this path. The European ATM master plan is informing this process.

The UK has some of the most capable and experienced airspace designers, accustomed to working in complex environments and in close cooperation with all stakeholders. The precise implications for the airspace will be subject to the exact location of the new airport, the orientation of the runways and both the distribution and volume of flights. Early high-level design and modelling exercises are necessary to understand the impact, and opportunities, more thoroughly.

The London airports combined currently generate about 1 million air transport movements (ATMs) each year. London has more airports and handles more passengers than any other city. The airspace is complex, but it works and it is safe. NATS, the Air Navigation Services Provider (ANSP) handled 2.154 million flights in all UK airspace during 2013. The peak UK traffic level of 2.471 million flights was achieved in 2007. Based on current forecasts it is reasonable to expect that the number of aircraft using London terminal airspace in the Hub opening year is unlikely to have increased by more than 20% over 2014, that’s just 10% above 2007. It is more likely that airspace planners will be considering a redistribution of flights rather than a large increase in their volume. NATS have confirmed that it is theoretically possible to achieve in excess of 1million ATMs at a new Isle of Grain hub airport.

The future airspace configuration for London will require long term planning, necessarily complex design, extensive consultation, testing and a robust transition, irrespective of where new runways are built.

At the UK national level, the CAA has published a Future Airspace Strategy Plan (FAS) for deployment by 2020. FAS will deliver a fundamentally more efficient route network in the busy London airspace. The London Airspace Management Programme (LAMP) will re-design the whole of the London Terminal Airspace (TMA) to take advantage of improved technology and procedures. This will complement modern aircraft performance to improve flexibility and airspace capacity. These initiatives will improve migration options and airspace flexibility for further airspace adaptations necessary for new runways serving London.

The issue of runway and airspace capacity are inter-connected, with the number of runways, layout, operating modes; aircraft fleet mix and runway utilisation percentage each impacting the design of the airspace. While the design of air traffic management routes, required navigational performance and density of airspace operations impact the flow rate that can be accommodated to or from the runways. An advantage of 4 runways at an IoG hub is a potential for several alternative operating modes, enabling much greater flexibility and resilience than airports with fewer runways. All options being considered by the Airport Commission will require detailed modelling to understand the operational, utilisation, resilience and ultimately the capacity implications of each operating mode.

The opportunities from developing a new site should include avoidance of the inevitable increased air route congestion to the western area of London associated with development of existing airspace infrastructure necessary to support increased Heathrow or Gatwick operations. While an east of London location may impact airspace of other nations, previous major international co-operative airspace re-design projects indicate that solutions can be agreed. The IoG site also offers the potential to develop over water aircraft routings to reduce the effect of aircraft noise above residential areas.

Any new runway capacity has the potential to impact neighbouring airports. The distance between Heathrow (LHR) and London City Airport (LCY) is 19nm. In comparison IoG to LCY will be approximately 23nm. In considering the impact of an IoG hub on industry, the Commission concluded that Heathrow, London City and Southend would need to close, our advice is that there is no operational or airspace reason for this conclusion.

Southend Airport's location is 5nm north of the proposed IoG site, with a runway direction (constrained by surrounding topography) that converges by some 30 degrees. If we draw a similarity with the Heathrow and Northolt situation, the latter has a similar physical separation but with about 20 degrees convergence. Specific operating procedures allow both Heathrow and Northolt to operate today so it may be possible to establish similar procedures for Southend. Detailed design and modelling will be required to examine this issue further.

There is no clear basis that can be derived from the NATS advice, or from separate airspace analysis, which concludes that airspace factors will require the closure of Heathrow, London City or Southend airports.

A 2-runway Gatwick or 3-runway Heathrow would impact all London airports as well as Southampton, Farnborough and Biggin Hill, and potentially require further increases of controlled airspace to the west, impacting both General Aviation (GA) and military operations.

In fact, any substantial increase of traffic resulting from any major airport development in the SE of England will require a similar level of consultation and assessment of changes to airspace infrastructure both domestically and internationally.

Achieving a successful transition for the current London airspace design to a design accommodating one or more new runways will necessitate significant planning, design, consultation, communication and coordination across the whole aviation industry. The precedent of FAS will undoubtedly inform the transition planning.

2. Strategic review of airspace impacts

2.1. Airspace serving London

The London airports currently generate about 1million air transport movements (ATMs) each year. London has more airports which combined handle more passengers than any other city. London airspace is also used by military, private and business aircraft and by training flights. The airspace is complex, but it works and it is safe.

NATS, the Air Navigation Services Provider (ANSP) handled 2.154 million flights in all UK airspace during 2013. The peak UK traffic level of 2.471 million flights was achieved in 2007. This fall in the number of flights is a tendency seen across Europe. It reflects the economic downturn since 2007 and a long term trend to the use of larger aircraft by airlines (Source Airbus, Boeing) and the increasing trend in passengers per flight (which is reflected in actual numbers for London airports).

Airspace in the UK is operated using standard international conventions. These make use of one way 3 Dimension route systems that segregate aircraft arriving and departing from London airports. Airports in close proximity, such as Heathrow, Northolt, London City and Gatwick operate safely together today using this system.

London's terminal airspace, located in the southeast of England below 24,500 feet, is nevertheless complex and congested. It is characterised by high levels of route interactions that require frequent controller intervention to manage. London's airspace structure is oriented to current airport locations and to forecast traffic demand, but is constrained by legacy issues.

An important characteristic that increases the complexity and inefficiency of the London airspace is the need for aircraft to hold while on their approach to London, waiting in turn to land. These holding areas or stacks block large areas of airspace, restricting the ability of air traffic controllers to provide optimum, noise efficient routings for both inbound and outbound aircraft. The operational capacity of the runways to handle the traffic demand can dramatically impact the need for aircraft holding and the efficiency of the airspace.

Heathrow in particular has such a high runway utilisation rate that perturbation due to weather, equipment failure or incident causes a significantly reduced landing rate. This is the primary reason that Heathrow has the worst flight delay and cancelation profile in Europe (Source: Eurocontrol). In these circumstances the airspace managers are obliged to hold and delay inbound aircraft, spreading airspace congestion across the UK and beyond. The introduction of a 3rd runway at Heathrow handling the same number of aircraft as today will immediately reduce the 90%+ runway utilisation levels to the normal recommended rates < 70% now seen at Amsterdam Schiphol and Paris CDG. Any additional flights at Heathrow will degrade the runway resilience, progressively negating the operational benefit of the 3rd runway and perpetuating the UK airspace congestion and the airports' delay and cancelation profile.

UK airspace strategy respects the global International Civil Aviation Organisation (ICAO) and European Single European Sky (SES) policies. ICAO and for Europe SESAR (Single European Sky ATM Research), have defined new capabilities to increase safety, capacity and efficiency. These policies and plans equally reflect the UK role as a part of the global air transport system. This is important; it means that airlines, airports and ANSP worldwide will be using globally harmonised solutions.

The future airspace configuration for London will require long term planning, testing and a robust transition, irrespective of where new runways are built. Airspace management and planning are not areas in which governments, industry and ANSPs can act alone. Aircraft, airports and airspace management rely on globally interdependent technologies and systems.

At the UK national level, the CAA has published a Future Airspace Strategy Plan (FAS) for deployment between 2013 and 2020. The FAS has been developed collaboratively by aircraft operators, airports, ANSPs, the military and regulators. FAS will deliver a fundamentally more efficient route network in the busy London airspace environment. It is intended to provide the capacity needs forecast to 2025.

The London Airspace Management Programme (LAMP) which will redesign the whole of the London Terminal Airspace (TMA) using Performance Based Navigation (PBN) will be delivered in phases between 2015/16 and 2019. The improvements in navigation accuracy and procedures will complement modern aircraft performance to improve flexibility and airspace capacity. Similar initiatives have already been successfully deployed at less complex airspace terminal areas in the USA and Australia.

The FAS and LAMP plan provides a clear mechanism to implement new technologies and capabilities from 2013 to 2020. Longer term, this work will improve migration options and airspace flexibility for further airspace adaptations for new runways serving London.

There is no reason why the regulations, technologies and procedures either in use today or planned in the UK, cannot be applied to design and implement a safe, efficient and environmentally optimised airspace structure to support a new airport at the Isle of Grain, that will take full account of existing airports in the London area and those in the Netherlands, Belgium and northern France. The precise implications for the airspace will be subject to the exact location of the new airport, the orientation of the runways and both the distribution and volume of flights.

Equally, corresponding initiatives that are progressing as a result of SES legislation provide the institutional mechanisms to deliver airspace solutions across international boundaries in the EU as a part of ensuring an efficient and homogenised airspace system for Europe.

The process is complex, as the existing FAS in London has shown, but given the planning horizon available, an efficient and safe solution will be achievable.

2.2. NATS support to the Airports Commission

NATS is the ANSP designated by government to operate en-route airspace in the UK. Part of this operation comprises the London Terminal Control Area, the airspace which serves the London airports.

In its response to the Commission, NATS sets out both the CAA and its own initiatives to develop the capabilities of UK airspace in context of the Single European Sky and ICAO frameworks. These are explained in more detail at Annex A.

The objectives of the work by NATS and CAA on future airspace strategies is to deliver a safer, more efficient air traffic management system with enhanced airspace and runway capacity. This work reflects developments in the air traffic management systems worldwide and is not a consequent of any London runway decision.

In response to the Commission Task 3.2a – Early Assessment of Long Term Options, the NATS advice sets out how aircraft are routed today in airspace serving the current configuration of runways, number of flights and mix of aircraft types.

NATS has been asked to provide a sense check on the number of ATMs and runways identified in the Airports Commission table. NATS has offered a high level response and notes that detailed analysis is necessary to determine what runway utilisation can be achieved, dependent on the mode of operation, mix of aircraft types, separation standards and other variable physical factors that can impact runway throughput. The consideration of factors that impact runway utilisation has been dealt with in a separate technical commentary on the Airport Commission assumptions. The NATS baseline response assumes that the LAMP has been completed (due in 2019) and that the consequent airspace and runway efficiencies will have been delivered.

With respect to airspace and the Isle of Grain airport option, NATS have confirmed that it is theoretically possible to achieve in excess of 1million ATMs, airspace complexity and the proximity of other airports may impact the figure that is actually achievable. It should be noted that all these variable factors will have a potential impact on any new runway option for London. NATS has made baseline assumptions and offered an indication of the impact on the ATM throughput of other airports. NATS warn that because of the many variable and unknown factors, that definitive impact analysis is not yet possible.

NATS was also tasked by the Commission to 'consider from an 'airspace' perspective the impact on the overall capacity on the current (and potential future) main airports serving the London area that could result from various developments that are being considered by the Airports Commission, as part of the Long Term measures.'

The NATS advice rightly points out that 'only by taking such a holistic view that considers mutual interactions, can an overall picture be developed of the change in overall ATM capacity be developed'. When considering the Thames Estuary Hub with an East/West runway orientation, NATS offers that other airports will not be able to operate as they currently do, in this case, not without significant impact to London City, Heathrow and Southend.

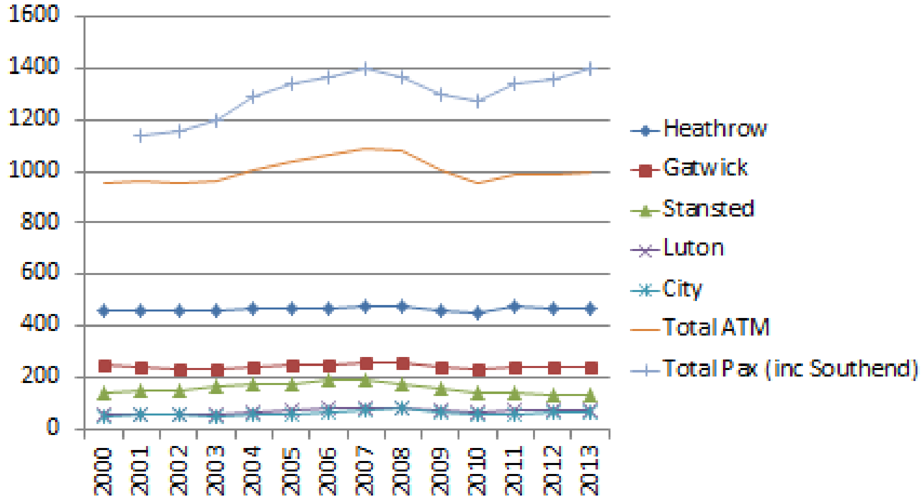
This assessment is more or less correct for any new runway location, not just the Isle of Grain. All other London airports will be affected by changes at one or another. The NATS conclusion to the Commission puts this statement into context:

'The mutual interactions of airports in close proximity (c.50 miles) means that an increase in the operation of one can have an impact on the operations of others due to the additional potential interacts between traffic on the arrival & departure routes. Thus the overall impact on the network as a whole has to be considered: whilst additional runways at existing location or new hub locations would increase capacity at that local/regional level, the impact on the ability of other airports to operate also needs to be considered. Detailed analysis using Fast Time Simulation to test predicted/expect traffic interactions would be required to take this analysis to the next level of detail to inform definitive recommendations'.

In other words, the airspace configurations serving all airports within at least fifty miles will be impacted, operations are expected to change, but until more details are available and detailed simulation and analysis is possible, it is not prudent to definitively determine what these changes will be.

It is important to remember that the number of aircraft using the airspace system in the UK and Europe has fallen or been broadly stable since 2007, while the number of passengers using London has risen. Based on current forecasts it is reasonable to expect that the number of aircraft using London terminal airspace in the Hub opening year is unlikely to have increased by more than 20% over 2014, that's just 10% above 2007. (Source: Eurocontrol, Boeing & Airbus forecasts). Put simply, it is more likely that the airspace planners for London will be addressing the redistribution of flights rather than a substantial growth in the number of flights serving London.

The airspace process is complex; it has many risks and variables. It is highly impacted by actual growth of the number of flights, but NATS will be able to adapt and deliver the airspace solutions necessary to support new runways wherever they are built, the impact on other airports cannot be definitively assessed without more concrete information.



Source: CAA Statistics

Figure 2-1 Trends in air transport movements versus passenger numbers

London	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total pax million	116.6	114.2	116.7	120.7	129.2	133.8	137.2	139.6	136.9	130.3	127.3	134	135	139.7
Total ATM '000s	969	962	955	967	1005	1038	1060	1088	1077	1003	954	992	986	994

Source: CAA Airport Statistics

Table 2-1 London airports annual passengers and ATMs

The peak passenger throughput of 139.6m for all London airports combined, occurred in 2007. The associated number of ATM for the same airports was 1.088million. The passenger peak was reached again in 2013, but with only 994k ATM.

The average number of passengers per ATM across the six London airports is growing:

- 2000: 121 passengers
- 2007: 128 passengers
- 2013: 140 passengers

Year	Heathrow Average Passengers / ATM	Gatwick Average Passengers / ATM
2010	146.6	134.3
2011	145.8	137.7
2012	148.6	142.4
2013	154.1	145.1

Source: CAA Airport Statistics

Table 2-2 Heathrow and Gatwick growth in passengers per ATM

2.3. Airports Commission comments – airspace perspective

2.3.1. Isle of Grain Airport

2.3.1.1. Operational viability

The Commission suggests that this option would probably require the closure of Heathrow and London City, although the greater capacity of the new runways would provide for a significant passenger capacity increase.

The runway orientations of London City and Heathrow are similar: the airports are just 19nm apart, closer than London City and an IoG airport (23nm apart), yet they are operated safely together. The main constraints in terms of flight profiles, both horizontal and vertical, will be caused as today by proximity of in/outbound routes to IoG (as opposed to LHR), but this should be no worse. The requirement will remain for both airports to operate with opposing landing directions (as today) caused by local wind characteristics, but in view of the distance between them this should be achievable.

2.3.1.2. Impact on industry

When considering the impact of IoG on industry, the Commission is more emphatic noting that it closes Heathrow and London City, and suggesting that Southend would also be lost.

Again there is no airspace derived basis to definitively reach this conclusion. It is clear that more detailed analysis will be needed which will be substantially impacted by the distribution and volumes of traffic and by the types of aircraft. Our advice is that there is no operational or airspace reason why LCY would be affected.

2.3.1.3. Capacity

The Commission notes that there will still be one net additional runway, given that London City and Heathrow will probably close. In this section Southend is expected to be reduced in capacity but to remain open.

2.3.1.4. Noise

The IoG option provides the opportunity to plan airspace such that a significant proportion of aircraft arrival and departure routes are over water. This is simply not the case for other options. The alternate runway solutions at Heathrow and Gatwick point to improved aerodynamic and engine capabilities on new aircraft and use of noise preferential routes over land, as their noise mitigation techniques. These will of course apply equally to all runway options but are substantially inferior to the scope for reduced noise impact at IoG. The Commission seems to have not explored this. For example IoG could potentially avoid the need for night curfew as a result of over water routings.

2.3.2. Southend (SEN)

Southend Airport's location is 5nms north of the proposed IoG site, with a runway direction (constrained by surrounding geography) that converges by some 30 degrees. If we draw a similarity with the Heathrow/Northolt situation, the latter has a similar physical separation but with about 20 degrees convergence. Limited operations are possible at Northolt (provided the airport always aligns its runway in the same landing/take-off direction as Heathrow), with westerly direction departures separated by an early turn to the north-west after take-off, and easterly direction arrivals conducting a special offset approach until short-final.

It may be possible to establish similar procedures for Southend, although the largely civil commercial nature of the operation and the ICAO/CAA procedure requirements that are associated with that may be problematic. It is also likely that the immediate departure spread of traffic from IoG (re 'Runway Operating Modes' and departure separations above) could place routes more adjacent to Southend than those currently experienced at Northolt. Detailed design and modelling will be required to examine this issue further.

2.3.3. Biggin Hill and Farnborough

Although not specifically mentioned in the NATS advice, the commercial operations at Biggin Hill and Farnborough will be important to accommodate (as they are indeed being addressed in the LAMP project). Biggin Hill is currently affected predominately by Gatwick and London City operations, and although resolution of constraints is challenging, the proposed location of IoG is not anticipated to worsen this situation.

In the case of Farnborough (and Southampton), the LAMP programme has improved integration of the airports into the London Terminal Control Area LTMA as one of its objectives. The location of IoG would have minimal effect on these operations, whereas a 2-runway LGW or 3-runway LHR would have more impact and potentially require further increases of controlled airspace to the west, impacting both General Aviation (GA) and military operations.

2.3.4. Interoperability of the Isle of Grain Airport

The institutional arrangements in place to ensure that airport, aircraft and air traffic management techniques are harmonised and are interoperable has been outlined in the introduction to this paper and are explained in more detail in Annex A.

The concepts, techniques and procedures used at airports in London, the nearby hubs in Schiphol, Paris and Brussels are either already, or will be consistent, harmonised and integrated, current programmes are converging any existing irregularities. The systems used on board aircraft and by pilots are also similarly interoperable. The Single European Sky legislation and resulting programmes begun in 2004, together with ICAO policies secures this path. The European ATM master plan is informing this process.

As has also been discussed, the specific airspace arrangements in place to support the existing airport configurations in London will need to be adapted to incorporate the new traffic pattern arising as a result of the introduction of any new runways.

The UK, Netherlands, France and Belgium are all members of Eurocontrol and the SES. They already collaborate closely together to optimise flight routes and airspace plans to support the needs of aircraft using their respective hub airports. The Functional Airspace Blocks in Europe are already tasked by the EU to deliver these objectives. London’s new Hub airport will be closer to the FABEC boundary, which will hence influence the design of the airspace configuration. Aircraft arrival and departure routings over the UK for AMS and BRU traffic may need to be revised, as will procedures for aircraft descending into/climbing out from a new IoG location.

The mechanisms and processes needed to develop the necessary solutions are already in place, in the UK, and with the formal relationships between the UK and its European neighbours at both the political and at the operational level.

The significant planning horizons necessary, likely in excess of five years, are available.

2.3.5. Equality of access

Wherever possible, equality of access to airspace for all airports, and airspace users, is a basic tenet of UK transport policy. In the London region this has historically created complexities when balancing the ‘legacy’ design of the airspace (built predominately around the major airports such as Heathrow and Gatwick), with growing requirements from expanding operations at other airports. This includes the growth of business aviation hubs, access by General Aviation (GA) and the military. An inevitable effect is a constrained capacity for certain airports or categories of airspace user, which places a high focus on airspace/procedure designs and technical support.

Any design conclusions that result in constraining one airport in favour of another will require CAA and DfT involvement as this becomes a national transport policy issue, not service provision. The only way to understand the extent of such potential issues will be by large scale modelling (NATS are probably best placed to support this).

For international airports the issue is similar, but any impact on their operations resulting from UK airspace re-design will offer different challenges. As mentioned above, the design goal must be to have no impact on other international airport operations, even though a collaborative programme of airspace/procedure re-design will have to take place. In fact, any substantial increase of traffic resulting from any major airport development in the SE will require a similar level of consultation and assessment of changes to airspace infrastructure both domestically and internationally.

3. Tactical review of airspace impacts

3.1. Airspace re-design

With current experience, developments in technology and modelling/analytical tools available there is believed to be no reason why a design solution for a new airport should not be successful. NATS have suggested the same, and our assessment supports this. Some of the more salient points in this respect are explained below.

Airspace is regulated by the CAA (the UK 'design authority'), with associated legal processes to ensure efficient design, access, safety and appropriate consultation. The Air Navigation Service Provider (NATS in this case) is responsible for all aspects of design, consultation etc in meeting European and UK targets for safety, and capacity, environmental and cost efficiency.

The London TMA (Terminal Control Area) comprises a high density of large airports, compared with any other global location. The interaction of traffic flows (horizontally and vertically) and the environmental impact of resultant ground tracks has typically been the most critical issue to realise optimum capacity in the TMA as a whole, whilst minimising noise and air pollution. Development of any site to substantially increase possible movements will require a large and necessarily complex re-design and consultation exercise.

Moving a hub from Heathrow to the Isle of Grain (IoG) will require not only a new design of the airspace and procedures to support the new location, but also entail a substantial movement of routings and changes to vertical profiles in and out of most of the other London regional airports. However, the challenges of developing a new site should be offset by avoiding the inevitable increased congestion to the western area of London associated with development of existing airspace infrastructure to support increased Heathrow or Gatwick operations.

3.2. International airspace boundaries

International airspace boundaries are complex but highly ordered, with bi-laterally agreed procedures and legal responsibilities for control of aircraft. This often comprises areas of delegation of Air Traffic Service (ATS) provision either side of a boundary, where operationally advantageous. Inbound jet aircraft will commonly leave cruising level approximately 100nm before their destination. From the east, the boundary with adjacent controlling authorities (Amsterdam, Brussels and the Maastricht Upper Area Control Centre which overlays them) is approximately 90nm from Heathrow. However, London ATC also operates in a small section of airspace to the east of the boundary, thus facilitating the descent and integration of traffic to the London area from this busy direction. The IoG site is approximately 50nms from the boundary, with resultant greater complexities around re-design of the airspace interfaces.

The earlier descent required (and equally the lower altitude of departing London traffic routing to the east) will require substantial changes to the route structure and procedures through Dutch, Belgian and partly French airspace, as busy crossing points exist to the east of the boundary with north/south transit traffic as well as aircraft in/outbound at the major 'local' European airports. An important design constraint will inevitably be to protect the capacity and operational viability of other European airports, not just those in the UK.

Previous major international co-operative airspace re-design projects suggest that solutions should be possible to find, although there will be an associated cost and timescale to complete such an exercise satisfactorily. There may even be opportunities to explore different cross-border airspace structures administered through collaboration between the respective Functional Airspace Blocks (FAB; see below) which could potentially improve efficiency of operation through larger, more integrated, TMA operations. This is ultimately a desire of both SES and SESAR. Early high-level design and modelling exercises would be recommended to understand the impact, and opportunities, more thoroughly.

In terms of military operations, changes to UK airspace in this region have historically required detailed negotiation with UK MOD as well as USAF-Europe (who operate to the North of the London TMA), and adjacent States military operators; particularly France, Belgium and the Netherlands - based on their operational need in the adjacent regions. Although in these timescales military airspace priority is not possible to predict, this will also need to be taken into account.

3.3. Runway operating modes

An advantage of 4 runways at IoG is a potential for several alternative operating modes, enabling flexibility and tailoring of the airport to (for instance) arrival or departure peaks, including peaks from/to different directions, and allowing resilience in the event of unforeseen events. The runway utilisation issues associated with different modes of operation (according to formal ICAO guidance and existing experience from other airports) are covered elsewhere in this submission. However, some issues associated with airspace are outlined here.

ICAO provides guidance material on parallel runway operations in the ICAO Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (SOIR) [ICAO Doc 9643]. The SOIR Manual describes certain standard procedures for operating parallel runways, but scaling this up to 4 parallel runways will require additional analysis. There is the obvious choice of mixed or segregated mode for each runway. In the simplest case, 4 independent runways could be configured for 2 landing/ 2 departure, all segregated. This would approximately double the capacity of the current Heathrow operation. It follows that tactical application of (for instance) mixed-mode on one or two of the runways would allow further overall increases, whereas favouring landing or departing traffic would equally be possible, depending on demand. The theoretical maximum would come with all 4 runways operating in mixed mode, although airborne separation between procedures will require detailed design and modelling (see below).

There are a further two modes of operation that could be applied to the airfield and airspace; these are Compass Mode and Terminal Mode. Under Compass Mode traffic would be arranged to arrive and depart depending on the compass direction. E.g. Aircraft departing to the north use the northern runway(s) and aircraft arriving from the south use the southern runway(s), and vice versa. The alternative is Terminal Mode. In this mode, traffic arrives and departs on the runway(s) closest to the terminal being used. Compass mode reduces cross-overs of traffic in the air, but requires more complex ground-handling. However Terminal mode will require a certain amount of airborne crossing of both arrivals and departures. This is possible, but has implications on SID designs, vertical flight-efficiency, ATC procedures and workload.

Finally, existing ICAO separation standards lay down requirements for separation between:

- departures from the same runway (timing and angle of divergence),
- departures from adjacent independent runways (angle of divergence), and
- departures and Missed Approaches from adjacent independent runways (angle of divergence).

In the timescales suggested it is likely that some reductions from current minima could be applied with advanced navigation and monitoring systems. However, without going further into detail here, route and procedure design will be critical to minimise constraints resulting from separation requirements. There will inevitably be trade-offs between capacity, flexibility and workload. All options being considered by the Airport Commission will require detailed modelling to understand the operational and ultimately the capacity implications of each operating mode.

3.4. Transition of the airspace

This subject is more fully covered in a separate document; a few issues concerning airspace in particular are mentioned here.

Transition will be the most complex piece for planning and execution of the airspace and should be the subject of detailed analysis as NATS has already noted. The implementation of the Future Airspace Strategy and the London Airspace Management Programme will inform the debate and will shape the plan for the next phase for London Airspace beyond 2019.

One assumption is that an interim step is required to enable a ‘soft opening’ of IoG, i.e. a stepped transition from LHR rather than ‘overnight’, designed to de-risk opening the new airport. This by definition retains an amount of traffic from Heathrow – diminishing through one or more transition steps. Whilst the ultimate conclusion is closure of Heathrow, such an interim design(s) of airspace and procedures increases the effort and investment.

A second assumption is that airspace to support full IoG operations will actually be a full and complete re-design of the whole LTMA, and interfaces.

Some high-level options will likely be;

a. Retain the current Heathrow/LTMA airspace design as is (at the time) and introduce new structures to operate and integrate a limited amount of IoG traffic. The complexity of this will be in-line with the required spread of routes in/out of IoG for the interim period, i.e., a limited route structure, matching just the carriers who initially transfer, could be relatively simple to manage. Once the new airport operations were satisfactorily tested, a second step would then see implementation of the complete new LTMA design and removal of procedures for Heathrow.
b. Implement the full new design for the LTMA, and at the same introduce revised but temporary procedures to allow LHR to maintain some operations. This would be less favoured as the interim structure supporting LHR would inevitably be inefficient, constraining any reasonable number of aircraft that remained at LHR. Any problems at the new airport requiring reversion would then be heavily constrained.
c. Create an interim design that allows split operations from LHR and IoG, as well as all other SE airports, then migrating to the full and final design in a second step. This option should be explored, but appears to increase complexity through additional design resource, testing, validation and training, system adaptation etc.

The switch-over of aircraft avionics including navigation system data-bases is also a large and complex exercise. Although this is a well proven global process which happens regularly (on somewhat smaller scales), it will need to be taken into account through consultation with the airspace users.

Overall any new runway in the SE of England will require significant planning, design, consultation, communication and coordination to achieve a successful transition.

4. Key issues for the Commission to address

1. More detailed work on the achievable optimum runway capacity for each airport option is needed, together with a clear understanding of the operational consequences and resilience of very high runway utilisation
2. Which airport option provides the best resilience in case of (for example) adverse weather or runway outage? Average and peak runway utilisation is as important as overall capacity in the smooth operation of the airspace and airfield.
3. ATM traffic across Europe is still significantly below the previous peak achieved in 2007, are the ATM forecasts consistent with those of aircraft manufacturers, regulators and ANSPs.
4. What are the options for airspace re-design; including impact on traffic flows and profiles outside UK airspace, if a design objective is to ensure traffic to/from adjacent major airports (e.g. Paris, Brussels, and Schiphol) is not constrained?
5. What are the operational consequences, risks, opportunities and likely timescale requirements for each option?
6. An airspace and route structure design must be included in the modelling (not just theoretical airport operations), and options for potential operating modes at the various airports illustrated. How will equitability of access to a revised airspace and route structure from surrounding airports be best satisfied?

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Appendix A. Strategic airspace background

A.1. Interoperability and harmonisation of airspace

Since the aviation industry first started needing air traffic controllers to track aircraft movements and manage airspace in the early 1930s, the introduction of any new technology or operational procedure has been undertaken in a very systematic way, often quite slowly. For several decades, the technology developments on board aircraft have outpaced those used in the air traffic control facilities. Fragmented airspace structures organised around national boundaries further increase the inefficiency, especially in Europe and the Middle East. This is why flight routes and profiles are often sub-optimal. The lack of runway capacity at hub airports further compounds airspace congestion as aircraft wait their turn to land.

This system, where each nation provides air traffic control services, including airspace management for its own territory, has served the industry well. But, as the importance of air transport continues to grow, this system which has provided a reliable and safe service to passengers and airlines will struggle to cope with the increase in traffic and the flexibility required by modern air transport.

To make greater gains in ATM efficiency, far-reaching cooperation is necessary. It requires an overarching global vision, with wider planning perspectives. It requires consistent implementation of facilities and services over larger geographical areas on the ground and in the air. It requires a global framework for performance measurement. Global interoperability and harmonization of aircraft and ground systems and procedures are key to making further improvements.

Figure 0-1 Airspace planning is global

Air traffic management and planning are not areas in which governments, industry and Air Navigation Service Providers (ANSP) can act alone. Aircraft, airports and airspace management are globally interdependent technologies and systems.

At ICAO's twelfth Air Navigation Conference held in 2012, a global Air Navigation Capacity and Efficiency plan was proposed by ICAO for the period 2013-2028. A final version was adopted by ICAO member states at the ICAO 38th General Assembly held in September 2013. It will inform and guide the selection of systems and capabilities delivered in ATM systems, implemented in aircraft and adopted by airports.

ICAO has developed the Aviation System Block Upgrade global framework, as part of the GANP, primarily to ensure that aviation safety will be maintained and enhanced, that ATM improvement programmes are effectively harmonized across the world, and that barriers to future aviation efficiency and environmental gains can be removed at reasonable cost.

The core of the ICAO Block Upgrade concept is linked to four specific and interrelated aviation performance improvement areas (PIA), namely:

a) Airport operations.

b) Globally-interoperable systems and data.

c) Optimum capacity and flexible flights.

d) Efficient flight paths.

The ICAO Global Air Navigation Plan has been adopted by States and endorsed by airport, airline and ANSP industry stakeholders ACI, IATA and CANSO.

A.2. Established institutional mechanisms for managing European airspace

A.2.1. Single European Sky

The Single European Sky (SES) initiative originated from within the European Commission in 1999 when there was general dissatisfaction with the levels of delay experienced by airlines and passengers. A High Level Group (HLG) was established by the Commission to investigate and report on the underlying issues. The general thrust of the HLG's recommendations were accepted by Member States of the European Union and resulted in four legislative measures which came into effect in April 2004:

- the Framework Regulation establishes the European Commission as the regulator for the civil sector and the Single Sky Committee to assist it in its regulatory activities;
- the Airspace Regulation which will establish a single European Upper Information Region and within it organize airspace into functional airspace blocks (FABs);
- the Service Provision Regulation establishes a common licensing system for civil ATM providers; and
- the Interoperability Regulation which aims to ensure that systems, equipment and procedures operate seamlessly.

Following review of the progress of the Single Sky in 2007 the Commission concluded that the desired results were not being realized fast enough and that further action was needed in other areas such as performance and the environment. This led to the publication of a communication entitled “Single Sky II - Towards a more sustainable and better performing aviation” which then formed the basis of the Commission’s SES II Package.

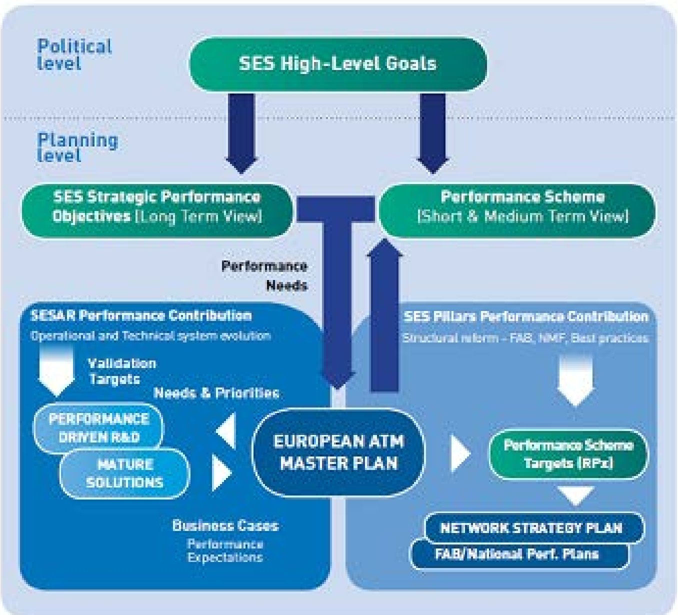

Figure 0-2 Single European Sky

A.2.2. SESAR – Single European Sky ATM Research

SESAR is the technological and operational dimension of the Single European Sky initiative to meet future airspace capacity and safety needs. It aims to define the future European air traffic management system which will eliminate the fragmented approach to ATM, transform the European ATM system, synchronise the plans and actions of the different partners and federate resources. With SESAR, the European ATM network will be re-engineered to become more efficient, better integrated, more cost-efficient and safer and environmentally sustainable ATM. The required changes will be supported and facilitated by accompanying regulatory measures.

SESAR comprises three major phases:

1. Definition Phase (2005-2008)
2. Development Phase (2008-2013)
3. Deployment Phase (2014-2020)

The Definition Phase produced the SESAR Master Plan based on future aviation requirements; the Plan identifies the actions, from research to implementation, needed to achieve SESAR goals from the perspective of each stakeholders group.

The Development Phase has produced the required new generation of technological systems and components as defined in the European ATM Master Plan.

A.3. Airspace structure

A.3.1. Functional Airspace Blocks

Although airspace is a common resource, air traffic management (ATM) in the European Union is still organised in a fragmented way, usually around national borders. This fragmentation potentially impacts on safety; it limits capacity, and above all, it adds to cost.

The key to improved capacity and efficiency, enhanced safety and lower costs of air navigation services, is through enhanced cooperation and integration across national borders. The establishment of functional airspace blocks (FABs) is intended to lead to increased cooperation and integration in air navigation service provision.

A.3.1.1. Defragmenting European Airspace

A Functional Airspace Block (FAB) is defined in the Single European Sky legislative package, namely Regulation (EC) No. 1070/2009 amending Regulation (EC) No. 549/2004, as an airspace block based on operational requirements and established regardless of State boundaries, where the provision of air navigation services and related functions is performance-driven and optimised through enhanced cooperation among air navigation service providers or, when appropriate, an integrated provider. The objective is to optimise air traffic flows and increase the efficiency of air traffic services in Europe.

The current reorganisation of the 67 airspace blocks in Europe - all based on national boundaries - into only nine functional airspace blocks is a major achievement.

The UK and Ireland FAB was the first to be established and has already delivered more progressive improvements to airspace efficiency, serving the SES objectives, than any other FAB.

Most air traffic activity in the southeast of England to the east and south will interface with FAB European Central (FABEC).

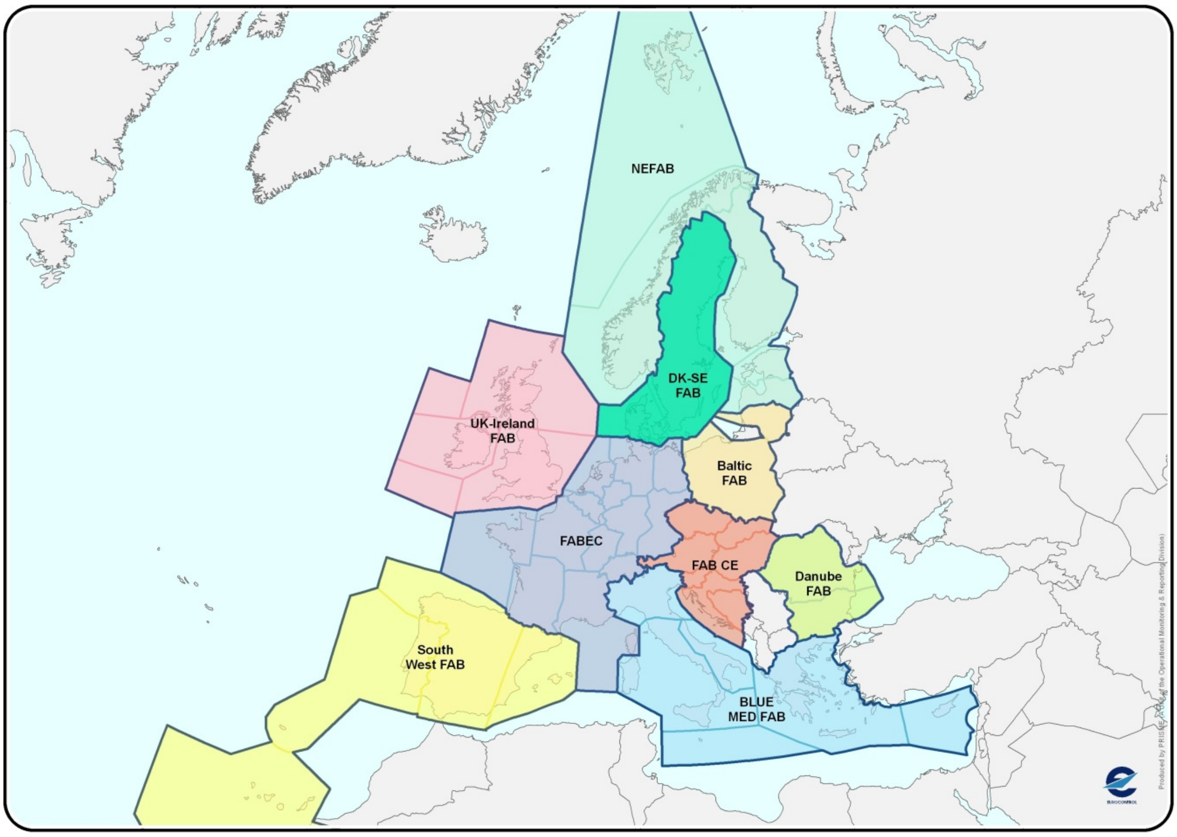

Figure 0-3 Functional airspace blocks

A.4. UK Airspace

The UK is a member of ICAO, a member of the EU, Eurocontrol and has established with Ireland the UK-Ireland FAB.

The Civil Aviation Authority (CAA) is responsible for Airspace policy. National Air Traffic Services (NATS) provide the air navigation services in UK airspace and; at the London airports and terminal areas.

International collaboration is the key to airspace efficiency, especially in Europe. For the UK, it is necessary to have efficient hand-off and acceptance of aircraft with European neighbours to the south, east and north, as well as with transatlantic neighbours to the west and northwest. Airports deliver and accept aircraft. The airspace that connects these airports must have the necessary capacity or delays occur. This requires homogenised design and coordinated, harmonised regulation across borders.

The 2010 Icelandic Volcano events clearly illustrated the consequences of severely constrained airspace, compounded by the difficulty in coordinating more than 40 regulatory regimes. London has more airports which combined to generate more air passenger throughput, than any other city in the world. The six current London airports generate about 1 million ATMs each year. The number of flights in UK airspace was 2.154m in 2013. Overall UK airspace handles about 6000 flights of all types per day.

A.5. Air traffic control

The guiding principle of air traffic control is to provide a safe and efficient service. UK airspace contains a network of corridors, or airways. These are usually ten miles wide and reach up to a height of 24,000 feet from a base of between 5,000 and 7,000 feet. They mainly link busy areas of airspace known as terminal control areas, which are normally above major airports. At a lower level, control zones are established around each airport. The area above 24,500 feet is known as upper airspace.

Standard Arrival Routes (STARS) and Standard Instrument Departures (SIDS) are used to segregate the arriving and departing aircraft at the same airports and at nearby airports, using strict route and altitude parameters. This is how London is able to manage multiple runways in relative proximity on a fail-safe basis.

The proximity of Heathrow to Northolt, London City, Farnborough, Gatwick, Luton and Stansted is managed using this process.

Until the technologies and procedures defined by ICAO and SESAR are implemented by airlines, airports and ANSP, the ability of air traffic controllers to optimise the arrival and departure flows is limited. This is one reason why for inbound aircraft, it is commonplace for ‘stack holding’ or extended ‘radar vectoring’ to be used by controllers to increase an aircraft’s track miles and hence absorb landing delay, especially at Heathrow and Gatwick. It is the tactical intervention of controllers that increases airspace throughput to the levels needed to support capacity demand. It also increases complexity and has a diminishing return as capacity limits are reached.

The current airspace management arrangements restrict an aircrafts’ ability to climb and descend efficiently and the ability of the airports to maximize the efficiency of their runways.

London has a complex and congested terminal airspace. It is characterised by frequent route interactions that require high levels of controller intervention to manage. Even so, the airspace has been designed to support the existing and planned traffic flows using technologies and procedures that have been superseded, especially by the aircraft on board system capabilities. In particular the advanced performance based navigation (PBN) capability of many aircraft is underutilised. Airports in Seattle and Brisbane, have successfully introduced PBN arrival procedures to increase airspace efficiency, capacity and environmental performance

At the UK national level, the CAA has published a Future Airspace Strategy Plan (FAS) for deployment by 2020. FAS will deliver a fundamentally more efficient route network in the busy London airspace. The London Airspace Management Programme (LAMP) will re-design the whole of the London Terminal Airspace (TMA) to take advantage of improved technology and procedures. This will complement modern aircraft performance to improve flexibility and airspace capacity. These initiatives will improve migration options and airspace flexibility for further airspace adaptations necessary for new runways serving London.

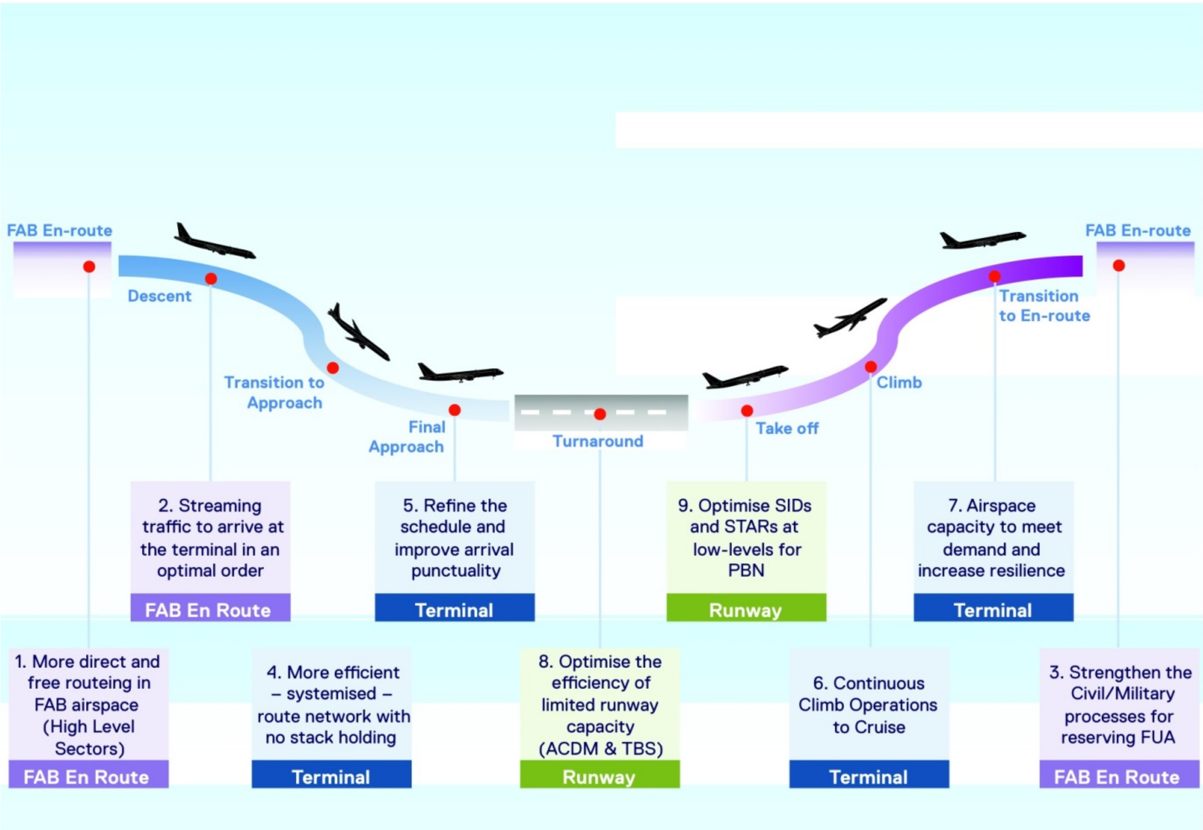

Figure 0-4 Future airspace strategy London

Appendix B. Developing technology (ATC and avionics)

To help put some topics previously made into context;

B.1. Point merge

The NATS 'LAMP' project (medium term re-development of the London TMA) will introduce Point merge procedures. This is an RNAV (Area Navigation) application that aims to simplify high-workload ATC vectoring of each aircraft in the latter stages of approach to an airport. In essence it replaces 'circular' airborne stack holding with flights sequentially following prescribed arcs, prior to turning towards the runway. A trade-off is the amount of airspace needed for the procedure design, and the resultant 'fit' of such between multiple airports which are currently in close proximity.

B.2. XMAN or cross-border arrival management

Long-range arrival management that aims to anticipate and partly mitigate airborne holding delays at the destination airport by early slowing of aircraft in the cruise and descent phases. It does not have to be coupled with Merge-Point, although one driver for both techniques is to reduce low-level airborne holding (with associated airspace congestion) for airports that typically receive demand in excess of their landing capacity. XMAN is being developed collaboratively between the major European ANSPs, with the goal of application at all airports where a benefit can be realised.

The above is current 'WIP', but even in anticipation of the implementation of XMAN it can be expected that providing a reasonable residual landing capacity at any location will ease the need for flight adjustments in order to absorb delay in-flight. Indeed a sudden loss of landing capacity at an airport with limited landing runways will cause delay problems not possible to immediately solve by such airborne/ATM techniques.

B.3. Performance Based Navigation (PBN)

PBN is basically a definition of *system performance requirements* for navigation capability, including accuracy and integrity (self-checking). It is not a defined design specification as such, but is developing as a way of defining flight accuracy requirements appropriate to the airspace. An anticipated application in this case would be to define a level of accuracy that would enable routes and procedures to be designed with reduced separation between them, enabling ATC to instruct aircraft to fly a 'procedure' in 3D (or 4D with appropriate time instructions, e.g. through XMAN) and reduce tactical ATC instructions with associated workload. RNP AR, the highest-performing type of PBN procedure, offers the most benefit to users by allowing for predetermined, precise, curved flight paths that optimally navigate within an airspace to reduce track miles, conserve fuel, preserve the environment, and increase airspace capacity. RNP AR procedures require specific aircraft functionality and pilot crew training in order to be used. The inter-dependencies between arrival and departure routes for a 4 runway airport will be complex, but definition of navigational standards through PBN will make it possible; with built in efficiency and repeatability hard to achieve in the current, more tactical, environment.

B.4. Functional Airspace Block (FAB)

The establishment of Functional Airspace Blocks is an existing EC legal requirement under SES for States to organise their airspace into joint areas. The objective is to improve strategic planning, tactical efficiency and cost-effectiveness. The FAB requirement has nothing to do with SESAR as such. UK and Ireland form one FAB (imaginatively titled 'UK-Ireland FAB'). France, Germany, Benelux and Switzerland form another ('FAB Europe Central', or FABEC). There are several other instances. Airspace re-design as outlined above will need close co-operation between States, but inter-FAB relationships are improving; e.g. XMAN is being developed between the two above-mentioned FABs.

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