Future Airspace Strategy Implementation (FASI)

London Terminal Manoeuvring Area (LTMA)

Airspace Change Proposal (ACP)
ACP-2020-043
ACP-2020-044
ACP-2020-045

Stage 2 Develop and Assess
Master Document

Roles

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Contents

References

1 CAP1711: CAA Airspace Modernisation Strategy 2023-2040 (CAP1711)

2 CAP1616: CAA Airspace Change Process (CAP1616)

3 All published documentation related to this airspace change proposal is available on the CAA Airspace Change Portal: ACP-2020-043 ACP-2020-044 ACP-2020-045

4 UK Air Navigation Guidance (ANG) (2017) - Guidance to the CAA on its environmental objectives when carrying out its air navigation functions, and to the CAA and wider industry on airspace and noise management. (Link)

5 Airspace Change Masterplan: iteration 2 (Link)

6 Performance-based Navigation (PBN): Enhanced Route Spacing Guidance (CAP1385)

7 Example Engagement Material (Redacted), see Ref 3 documentation available on the CAA Airspace Change Portal

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1. Introduction

1.1 About this document

1.1.1 This document is part of the set required for the UK's airspace change process known as CAP1616, Stage 2 Develop & Assess:

- Step 2A Option Development: Design Options & Design Principle Evaluation
  Develops the options for airspace design for the en-route network and airport connectivity for the London Terminal Manoeuvring Area (LTMA) which address the Statement of Need and align with the Design Principles, filtering out those that are unlikely to be viable.
- Step 2B Options Appraisal: Initial Options Appraisal
  Assesses the remaining airspace design options, a further opportunity to filter out the least suitable.

1.1.2 The scope of this project includes the airspace network for the LTMA area, and connectivity with 12 Future Airspace Strategy Implementation (FASI) airports. The project will be implemented over a minimum of 3 separate deployments, to accommodate the complexity of the required changes and the vast interdependencies with the airport Airspace Change Proposals (ACPs). To enable this, this stage has been completed in modular form as described in paragraph 2.2.4 below.

1.1.3 Section 2 of this document describes the design option methodology which has been undertaken across all design option modules, and the engagement activities undertaken. This is applicable across the network design options and the airport connectivity designs.

1.1.4 Section 3 presents the overall baseline for the LTMA airspace. This 'Do Nothing' option includes traffic data, current traffic flows[1], and identifies constraints across the airspace.

1.1.5 Section 4 describes the design development for network options, demonstrating how engagement feedback has developed and rationalised the design options.

1.1.6 Section 5 introduces the separate complementary modules, which provide discrete detail for each airport's arrival options. Departure options are generally designed from the ground up, so the primary responsibility at this stage sits with relevant airports, and the network option will enable connectivity.

1.1.7 A Design Principle Evaluation (DPE) and Initial Options Appraisal (IOA) has been completed for all concepts listed in Section 4 and Section 5, to determine whether they are viable to progress to Stage 3 or are discounted at this stage.

1.1.8 Section 6 concludes with a summary table presenting the overall output for all LTMA designs.

1.1.9 It is advised that all stakeholders read the entirety of this Master document, which includes the network section. Stakeholders may have greater interest in specific airport connectivity options, so these are contained in separate modules.

1.1.10 During this stage we reengaged with the stakeholders engaged during Stage 1. We provided baseline information, initial design concepts and known design constraints for each element of the design options. We asked our stakeholders for feedback relevant to their interests. This document summarises the engagement activities and demonstrates how stakeholder feedback has influenced the design option development and developed our comprehensive list of viable options. The supporting appendices evidence the engagement undertaken.

1.1.11 The document includes the Design Principle Evaluation (DPE) which sets out a qualitative assessment of each option against each of the Design Principles. The evidence is high level and based on subject matter experts (SMEs), feedback received from stakeholders and the evolving design work. The DPE reduced the comprehensive list of potential options to a shortlist of options.

[1] Traffic flows are considered both from a network perspective (traffic directions across the entire LTMA network) and for each airport (predominant directions from which traffic leaves the LTMA network towards the airport).

1.1.12 An Initial Options Appraisal (IOA) was undertaken on the viable Design Options and results in the shortlist of options which will progress to Stage 3 for development and consultation.

1.1.13 This document describes the activities completed and supporting documentation required for all CAP1616 Stage 2 activities.

1.2 Where are we in the Airspace Change Process?

1.2.1 We have completed Stage 1: Define, where we recognised the need for an airspace change and the design principles underpinning it. We are now in Stage 2: Develop and Assess. This document set comprises Steps 2A and 2B and is a common document set covering three NERL (NATS En Route Limited) LTMA ACPs: ACP-2020-043, ACP-2020-044 and ACP-2020-045.

1.2.2 The LTMA cannot change in a single deployment; it is too large and complex. The Stage 2 document set is common across three ACPs because at this early stage we know the overall region where change would occur, but the deployment schedule for the implementation of the ACPs is not yet determined.

1.2.3 The deployment schedule will be coordinated between NERL, ACOG (Airspace Change Organising Group) and the sponsor airports at Stage 3 (see paragraph 1.8.2). The ACPs will then be aligned to deployment areas, identifying specific airports and relevant airspace for each deployment. Stage 3 will be completed for each deployment in a complementary manner, over a phased period for each planned implementation. As such, this document set covers the entirety of the LTMA deployment scope area. NERL, ACOG and the CAA have agreed this approach to Stage 2.

1.3 Background & Scope

1.3.1 This ACP is sponsored by NERL and is part of a programme referred to as the Future Airspace Strategy Implementation (FASI).

1.3.2 The FASI programme seeks to modernise the enroute airspace in southern England and Wales by requiring involved airports and NERL to improve their routes and airspace in accordance with the Civil Aviation Authority's (CAA's) Airspace Modernisation Strategy (AMS, Ref 1). Due to the proximity of airports and their airspace, such redesign requires collaborative work between ACP sponsors within the region.

1.3.3 NERL, and the airports across the south, are all working on separate, but coordinated, airspace change proposals to meet the AMS objectives. Each airport's FASI proposal interacts with, and has some reliance upon, the FASI proposals of other airports and of the NERL FASI ACPs related to changes to the UK's ATS (Air Traffic Service) route network (see Section 1.8).

1.3.4 This ACP is one of three interdependent NERL ACPs, known as LAMP D2, D3, and D4. The objectives of these are to modernise the enroute network serving the LTMA and connectivity with relevant airports within the airspace. This includes the airspace managed by London Area Control (LAC) and London Terminal Control (LTC) and a full redesign of the LTMA, out to the FIR (Flight Information Region) boundary at the east and south.

1.3.5 The aim is to modernise the enroute network through systemisation of traffic utilising the LTMA, enhance capacity by reducing conflicts, whilst minimising negative environmental impacts.

1.3.6 Figure 1 shows the lateral area of scope for the proposed changes. Vertically, the changes will extend from a lowest level of FL70 (~7,000 ft) (below this level the changes will be made by an airport), up to FL245 (~24,500 ft), where the ATS routes will interface with the remainder of the extant upper ATS route network[2]. Where new and/or amended ATS routes result below FL245, it is likely that complementary amendments will be made to the higher ATS routes to ensure alignment and reduce complexity.

[2] It is proposed under a separate ACP (ACP-2021-072) to implement Free Route Airspace (FRA) in the Upper Airspace (FL245+); currently it is planned for this change to Upper Airspace to be implemented subsequent to the deployment of this ACP.

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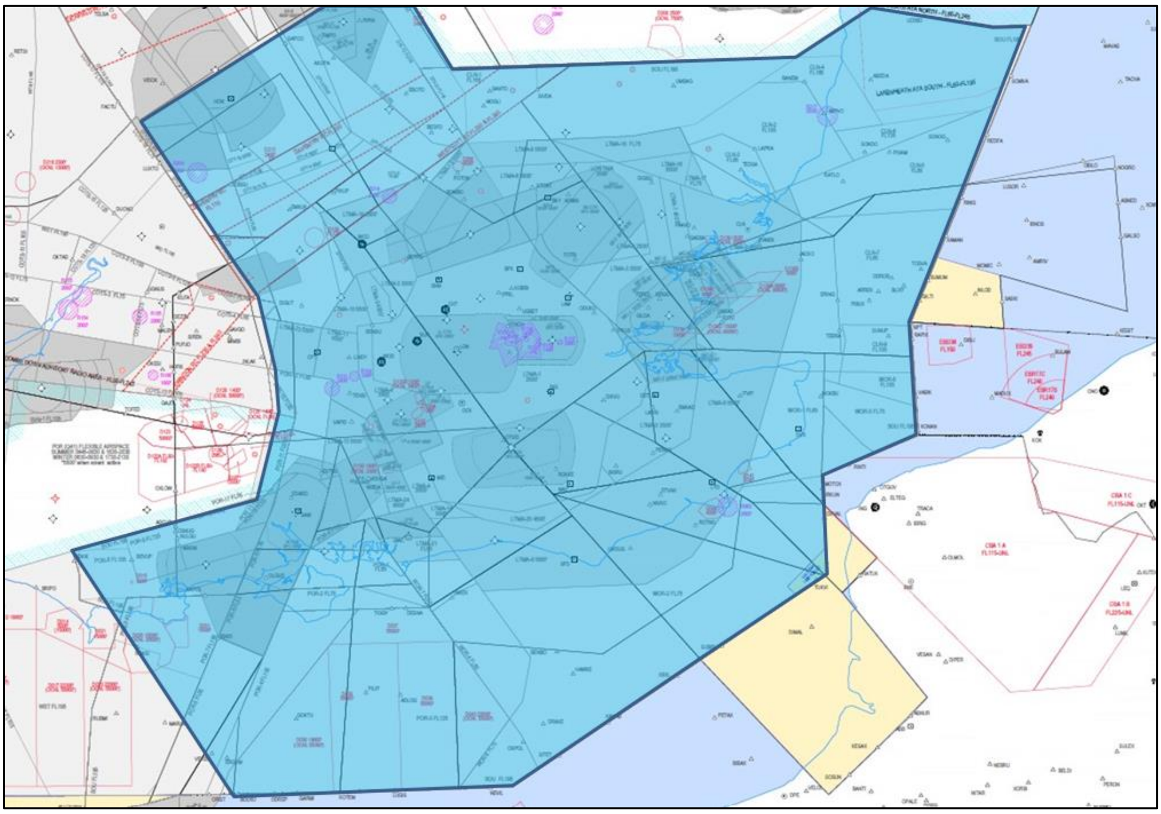

Figure 1 Lateral extent of the scope area for LTMA ACP changes

1.3.7 Each airport has its own ACP to amend arrival and departure routes below 7,000ft. These share airspace design interdependencies with this NERL-led network ACP that sits above it. NERL and the airports are working collaboratively to develop the design options associated with the respective ACPs for each airport/the network, with the airports leading below 7,000ft and NERL leading at and above 7,000ft. Should an airport intend to design a continuous procedure that starts or ends above 7,000ft, then NERL will collaborate with the airport to determine how this may be achieved.

1.3.8 The Stage 2 options development work presented in this document has been conducted across the entire scope area and is consistent across all three NERL ACPs. This approach facilitates consistent and holistic option development and reduces negative impact on stakeholders who may have interest across multiple deployment areas at this stage.

1.3.9 Due to the interdependencies and the complexities of the FASI programme, design options are conceptual at this stage, with high-level concepts presented which address the Statement of Need and align with our Design Principles.

1.3.10 This approach provides flexibility to ensure that NERL can incorporate the individual airport design options into the overall network design as the ACPs progress through the CAP1616 process. Working closely with stakeholders, NERL has developed concepts for the ATS Route Network, and Airport Arrival Structures for each airport listed below, presented as discrete concepts for each airport.

1.3.11 Due to the complex interactions between the UK and neighbouring Air Navigation Service Providers (ANSPs) which form part of the pan-European ATS network, at Stage 2 there is an underpinning assumption that the major current traffic flows and route orientations into and out of the SE of the UK will remain as per today. Stage 3 will identify and resolve the conflicts and interdependencies in granular detail.

1.3.12 The scope of the NERL changes includes, but is not limited to

- Airspace and route structures (at & above 7,000ft)
- Improvements to the interfaces with neighbouring ANSPs.

- The interface with airports within the LTMA airspace, in particular Biggin Hill, Bournemouth, Farnborough, Gatwick, Heathrow, London City, Luton, Manston[3], Northolt, Southampton, Southend and Stansted.

1.4 Recent History of Airspace Change in the region, including those imminent & adjacent

The following list summarises changes to the LTMA since 2016:

1.4.1 In 2016 NERL, London City, Luton and Stansted jointly implemented changes at lower and higher altitudes to London City arrivals and departures, Luton departures and Stansted departures. For full details see this CAA web page.

1.4.2 In 2017, NERL introduced RNAV1 separated routes for LTMA traffic to/from the south coast, known as SAIP AD1. For full details see here.

1.4.3 In late 2018 NERL made changes to higher altitude connectivity between the south coast and the Channel Islands and France, known as SAIP AD3 (link), and also to the interface between the Dutch boundary and the London area, known as SAIP AD4 (link).

1.4.4 In late 2019 NERL made a multi-part change known as SAIP AD5 (link), addressing a Birmingham Airport higher altitude route requirement, and a minor technical change to Heathrow's balance of holding flows at higher altitudes. The latter minor technical change is part of the LTMA.

1.4.5 In early 2020 Farnborough Airport introduced changes to their departure and arrival routes at both lower and higher altitudes (NERL adapted the LTMA as part of this implementation), see this link.

1.4.6 In early 2022 NERL and Luton Airport introduced changes to Luton's arrivals, separating them from the previous design that used combined arrival flows with Stansted.
This is known as SAIP AD6 (link).

1.4.7 In early 2023 NERL will introduce major changes to the southwest of the UK abutting the London TMA area; at higher altitudes (link) and upper flight levels (link). This LTMA ACP will be compatible with the western changes. Any dependencies identified between the network designs will be managed by NERL in later stages of the process.

1.4.8 NERL are also progressing changes to the Manchester TMA region (link), planned for implementation in 2027. Any dependencies identified between the network designs will be managed by NERL in later stages of the process.

1.5 Why must this change happen now?

1.5.1 The enroute network has evolved piecemeal over many years rather than in a large-scale coordinated manner and has typically been defined by the use of ground-based navigation beacons. Improvements in navigation technology (e.g. satellite-based navigation) have removed these limitations and hence it is possible to undertake a complete redesign of the route network within the fixed constraints.

1.5.2 This aims to give benefits in safety, environment, and capacity. Undertaking such a fundamental redesign of the airspace is considered a once in a generation opportunity and will secure efficiencies and benefits for many years to come.

1.6 Statement of Need

1.6.1 The Statement of Need (SoN) initiated the ACP and was submitted to the CAA in November 2017. This was superseded in February 2018 with a revised version. The full document is published here on the CAA's Airspace Change Portal.

1.6.2 The SoN presents the reasons for change. The primary aims are to modernise the network, including optimal alignment and connectivity with relevant airports, to enable capacity benefits and minimise negative environmental impact. This is driven by the UK Government's AMS – see 1.3.2.

1.6.3 The comprehensive list of design options was created to address the SoN.

[3] Manston Airport is included as they have an active FASI ACP, although it is not currently an operational airport.

1.6.4 This SoN was written pre-COVID-19 pandemic, and the subsequent reductions in air traffic. This airspace change is designed to address long-term growth and capitalise on available modern navigation capabilities to facilitate efficiencies and environmental benefits, so this SoN remains valid, for the long-term benefit of the aviation industry and the UK economy.

1.6.5 There are similar network ACPs which are driven by the AMS. These include NERL's Scottish TMA ACP (ACP-2019-74) and Manchester TMA ACP (ACP-2019-77). We have considered these as part of our preparation for this proposal and have taken a similar concept-based approach to the development of the design options.

1.7 Design Principles

1.7.1 The Design Principles (DPs) and their original priority status were set following engagement with representative stakeholder groups and feedback received during CAP1616 Stage 1, which was completed in January 2020, and published on the CAA portal here.

1.7.2 Since then, an additional DP has been added to comply with the CAA's requirement for an AMS-related DP (DP10, Policy: AMS Alignment).

1.7.3 Originally, DP2 (fuel performance) and DP3 (CO_2 emissions) were afforded Priority C (DPs are graded A-C, with A being highest priority). However, environmental priorities – specifically climate change due to greenhouse gas emissions – have become more prominent, since this airspace change was initiated, and the priorities of the Stage 1 Design Principles originally set.

1.7.4 During our stakeholder engagement, we stated that we intend to increase the priority of these two DPs from C to B and asked for feedback on this. Stakeholders did not object to this proposal. Gatwick Airport commented that this should not be to the detriment of capacity and resilience. As DP1 (Resilience) and DP8 (Capacity) are both Priority B, this brings the environmental factors to equal priority with these factors.

1.7.5 Given the response from stakeholders, we have reprioritised DP2 and DP3 from C to B. Table 1 shows the Design Principles, with revised priority status and DP10 added.

DP	Priority	Quick Ref	Description
0	A	Safety	Safety is always the highest priority
1	B	Operational	The airspace will enable increased operational resilience
2	B	Economic	Optimise network fuel performance
3	B	Environmental	Optimise CO_2 emissions per flight
4	C	Environmental	Minimising of noise impacts due to LAMP influence will take place in accordance with local needs
5	C	Technical	The volume of controlled airspace required for LAMP should be the minimum necessary to deliver an efficient airspace design, taking into account the needs of the UK airspace users
6	C	Technical	The impacts on GA and other civilian airspace users due to LAMP will be minimised
7	C	Technical	The impacts on MoD users due to LAMP will be minimised
8	B	Operational	Systemisation will deliver the optimal capacity and efficiency benefits
9	B	Technical	The main route network linking airport procedures with the En Route phase of flight will be spaced to yield maximum safety and efficiency benefits by using an appropriate standard of PBN
10	A	Policy	Must accord with the CAA's published Airspace Modernisation Strategy (CAP1711) and any current or future plans associated with it

Table 1: Design Principles: Description and Priority Level (revised after stakeholder engagement)

1.7.6 The design concepts presented in this document are evaluated against these DPs and these priority levels, with stakeholder feedback and input from SMEs incorporated. This is used to determine which options are progressed to Initial Options Appraisal and which are discounted. See Section 2.5 for further detail on the methodology applied.

1.8 Interdependent ACPs

1.8.1 The LTMA airspace change programme includes 12 airport ACPs and these 3 NERL ACPs. These ACPs are independent, but, due to geography, also interdependent. As the en-route ANSP, we are interdependent with all participating LTMA airports in the regional cluster, as shown in Table 2.

FASI ACP Sponsor	ACP Reference	Interdependency
NERL LTMA (FASI)	ACP-2020-043 ACP-2020-044 ACP-2020-045	Direct dependency. Deployment sequence will determine dependent airports. These ACPs are dependent on each other. Network changes will be complementary and may require revision in subsequent deployments.
Biggin Hill Airport	ACP-2018-69	Direct dependency with Biggin Hill ACP as delivering network connectivity for EGKB arrival and departures.
Bournemouth Airport	ACP-2019-43	Direct Dependency with Bournemouth ACP as delivering network connectivity for EGHH arrival and departures.
Farnborough Airport	ACP-2022-038	Direct Dependency with Farnborough ACP as delivering network connectivity for EGLF arrival and departures.
Gatwick Airport	ACP-2018-60	Direct Dependency with Gatwick ACP as delivering network connectivity for EGKK arrival and departures.
Heathrow Airport	ACP-2021-056	Direct Dependency with Heathrow ACP as delivering network connectivity for EGLL arrival and departures.
London City Airport	ACP-2018-89	Direct Dependency with London City ACP as delivering network connectivity for EGLC arrival and departures.
Luton Airport	ACP-2018-70	Direct Dependency with Luton ACP as delivering network connectivity for EGGW arrival and departures.
Manston Airport	ACP-2018-75	Direct Dependency with Manston ACP as delivering network connectivity for EGMH arrival and departures.
Northolt Airport	ACP-2018-66	Direct Dependency with Northolt ACP as delivering network connectivity for EGWU arrival and departures.
Southampton Airport	ACP-2019-03	Direct Dependency with Southampton ACP as delivering network connectivity for EGHI arrival and departures.
Southend Airport	ACP-2018-90	Direct Dependency with Southend ACP as delivering network connectivity for EGMC arrival and departures.
Stansted Airport	ACP-2019-01	Direct Dependency with Stansted ACP as delivering network connectivity for EGSS arrival and departures.

Table 2 LTMA ACP Dependencies summary

1.8.2 ACOG have been commissioned by the DfT and CAA to create and manage the Airspace Masterplan (Ref 5). This identifies interdependencies between sponsors and will help coordinate ACP work as each strand progresses. Their role includes creating and monitoring a deployment plan based on which ACP(s) must deploy in which sequence, to allow overall network implementation. Additionally, they are included in bilateral meetings between FASI sponsors in order to observe, provide advice and guidance on the programme.

1.8.3 It may be necessary to make changes above 7,000ft to adjacent routes as part of each network ACP, outside their nominal deployment area, in order to evolve towards the final LTMA-wide network. This includes ensuring this ACP will be compatible with adjacent western and MTMA interfaces, as noted in para 1.4 above.

1.8.4 There is potential for conflicts across these interdependent ACPs which may lead to compromises and or trade-offs. These will be considered further at Stage 3 of the CAP1616 process.

1.9 Potential Interactions and Dependencies with other aerodromes / ACPs

1.9.1 There are dozens of smaller aerodromes and other sites of aviation activity situated under the LTMA. These sites are primarily used by light general aviation. The aerodromes do not have, nor are they implementing, any permanent published procedures connecting them to the ATS route network of which this ACP would need to take account. As we move through to Stage 3, we will engage with these sites as appropriate for each deployment.

1.9.2 Blackbushe, Cambridge, Denham, Dunsfold, Fairoaks, Lasham and Odiham aerodromes currently use neighbouring FASI airport's procedures. Although they do not have their own FASI ACP, connectivity will be maintained but may require changes to their operation.

1.9.3 Aircraft transiting to/or from other nearby airports, which currently route through the LTMA, such as Birmingham (EGBB) or Bristol (EGGD), will benefit from the proposed network improvements and have been included as stakeholders for this ACP, however there are no dependencies on any changes these airports are undertaking.

1.9.4 NERL is in regular engagement with these airports to ensure that the designs proposed are compatible with the airports' known aspirations or extant procedures. This will ensure connectivity is maintained.

1.9.5 The changes contained within this ACP will complement the changes being made to the NERL led MTMA ACP. The changes proposed in the LTMA ACP consider the MTMA proposed changes and will ensure that any future interdependencies are identified.

1.10 Altimetry – altitudes, heights and flight levels

1.10.1 Aircraft can use different vertical references when flying. 'Altitude' specifically means the distance of an aircraft above mean sea level using a local or regional pressure setting, 'height' specifically means the distance above the surface/terrain using a localised pressure setting, and 'Flight Level' (FL) is a standard reference for aircraft at higher levels using a common altimeter setting, in hundreds of feet, so an aircraft at FL90 is 90 x 100 = 9,000ft above the standard reference.

1.10.2 Controllers need to use reference settings which are common for the aircraft under their control and those adjacent, hence the use of altitudes and flight levels.

1.10.3 All of the changes proposed within this ACP are at or above an altitude of 7,000ft which is above the transition altitude[4] (TA). Above the TA aircraft fly with reference to Flight Levels, hence in this document we generally refer to flight levels (FLs).

1.11 What do we mean by systemisation?

1.11.1 Systemisation refers to the process of reducing the need for human intervention in the air traffic control system. This can be achieved by utilising improved navigation capabilities to develop a network of routes that are safely separated from one another so that aircraft are guaranteed to be kept apart reducing the need for air traffic control to intervene so often. Systemisation can reduce complexity whilst benefiting safety and capacity. A systemised route network is characterised by the following:

- An air route network where climbing and descending aircraft follow a structured route system based on their departure point and/ or destination.
- Route design is predicated on the use of Performance Based Navigation (PBN) which enables very accurate track conformance to routes. This allows the required distance between routes to be determined using the process and reduced separations detailed in CAP1385 (Ref 5).
- Systemising ATS routes should reduce the amount of tactical intervention required, by optimising the routings available within a given volume of airspace.
- The allocation of traffic on routes is driven by traffic data, both historical and future, and the input from sector controllers.
- Although systemisation reduces the amount of controller intervention required, there will still be instances where controllers will need to use tactical controlling techniques (radar headings or rerouting between waypoints) for expedition and to resolve conflictions.
- It is recognised that the introduction of systemised airspace may introduce additional planned track mileage for some routes, while shortening others.

[4] The altitude at which aircraft change to using FL as the altimetry reference for maintaining vertical separation (i.e., change from the local airport pressure setting to standard pressure: 1013 hPa). This is 6,000ft for airports within the LTMA.

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1.12 ACP Categorisation Level

1.12.1 The above sections (1.8 & 1.9) present the magnitude of the proposed changes, and the interdependencies with which this ACP is linked. Our approach to Stage 2 is therefore broad, high-level and qualitative (by necessity, given the interdependencies with other ACPs).

1.12.2 At the assessment meeting NERL explained the changes which will be included and progressed under this ACP are only to the enroute airspace, at or above 7,000 ft. Given the potential for NERL to influence how one or more of the interdependent airports alter traffic patterns below 7,000ft over an inhabited area, NERL expects that, by the definitions in CAP1616, this change will be categorised as a Level 1 ACP.

1.12.3 As airports are pursuing their own interdependent ACPs to change the low-level airspace (below 7,000 ft), NERL would consider it disproportionate to consider noise impacts within this ACP and therefore proposes the process is scaled as follows.

NERL intends to:

1.12.4 Continue to work closely with airport sponsors on options development and, as changes are being progressed by an airport, provide proportionate support to their consultations (where requested and appropriate).

1.12.5 Continue to engage with airport sponsors to determine suitable arrival structure locations and departure connectivity points.

1.12.6 Consult with relevant identified stakeholders on the proposals for change to the enroute network above 7,000 ft.

1.12.7 Produce en-route network CO_2 emissions analysis (during Stage 3).

NERL does not intend to:

1.12.8 Consult on routes below 7,000 ft. If no changes below 7,000 ft are proposed by airports, the LTMA design will interface with the extant routes.

1.12.9 Proactively consult local communities.

1.12.10 Produce noise analyses (unless related to ATS route changes below 7,000 ft and not within the scope of one of the FASI associated airport ACPs).

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2. Methodology

2.1 Baseline Methodology

2.1.1 Our first step in developing a comprehensive list of options which address the SoN was to understand what happens today – the baseline. This includes the current enroute and airport routes and structures, traffic flows, traffic mix, and identification of design constraints.

2.1.2 To identify the baseline, we took the following steps:

- Engaging with the airport sponsors to understand their current operations and future aspirations;
- Engaging with airlines, via the NERL Lead Operator Carrier Panel, to understand their future fleet capabilities and arrival structure preferences;
- Analysing flight track data to assess how aircraft operate in LTMA airspace; and
- Engaging with Subject Matter Experts (SMEs) on the current LTMA operation.

2.1.3 The LTMA baseline, which is based on 2019 data, is described in Section 3. Extrapolating the baseline using traffic forecast figures would present the 'Do Nothing' option.

2.1.4 Traffic data from 2019 is used to baseline, as this is the most up-to-date and credible data to demonstrate a 'representative' year for air traffic. In 2020, there was an unprecedented drop in demand for air travel due to the COVID-19 pandemic. Whilst traffic levels are returning, they have fluctuated throughout the pandemic and are not currently as credible to use as a baseline. See Section 3.9 for forecast detail.

2.2 Design Development

2.2.1 The options proposed to modernise the LTMA airspace have been developed within a user centred design process, using first-hand knowledge to develop design concept options which are theoretically feasible within the constraints and demands of the airspace.

2.2.2 Our design options consist of two primary streams:

- ATS route network concepts, to be considered and applied to the region; and
- Arrival structure concepts to be considered and applied within broad regions of each airport's design envelope.

2.2.3 Network options will provide connectivity to airport SID end points / departure connectivity points. Departure procedures are being developed by airports under their ACPs. NERL's commitment to the airports is that their departure connectivity will be collaboratively developed to align with the network option(s) progressed in this ACP. At this stage the airport departure options are not yet mature enough to allow detailed evaluation by NERL; this will come in Stage 3.

2.2.4 Given the complexity of the airspace, the design option development was separated out into 13 modules: one for the enroute network options (within this document); and one for each of the 12 FASI airport's arrival options.

2.2.5 Considering each module independently ensures the redesign is manageable, consistent across all aspects, and that any interdependencies can be systematically factored in to develop the optimal holistic design for this complex airspace. It retains the maximum amount of flexibility at this early stage of the process. The design work has advanced in an iterative, high-level and qualitative manner. It would be disproportionate to attempt to conduct quantitative analysis at this early stage.

2.2.6 Initial concept options were developed for each module by NERL SMEs from air traffic control, safety, human factors, data analytics and airspace change. The concept options, which included radical solutions[5], have developed in coordination with our key stakeholders, the airport sponsors, to ensure the options proposed are compatible with the airports' own ACP designs.

2.2.7 NERL SMEs and the airport sponsors then worked closely in a series of workshops (summarised in Section 7) to review these early concepts for both network and airport arrival structures, generating feedback, developing broad concepts and identifying constraints at a high level. The outputs from these collaborative design workshops were recorded in Airspace Development Workshop Records (ADWR), which were shared with airport sponsors.

2.2.8 NERL undertook visualisation simulations with SMEs, including Air Traffic Control Officers (ATCOs), and airport stakeholders, to assess the operability of some design options. This type of simulation is used to run traffic on planned profiles to demonstrate how multiple design options could operate in a realistic looking ATC setup. It is emphasised these are conceptual in nature only and do not necessarily represent the final location of tracks/arrival procedures.

2.2.9 There were two key aspects to determine for each airport: the possible types of arrival structure and the geographic feasibility. There are a variety of factors which influence both, e.g., current traffic flows, airport runway demand and constraints such as Military Danger Areas. For geographic viability, airspace was sectioned into nine elements, using the cardinal / intercardinal points as reference, and the airport overhead. Some options were discounted at this stage as unviable.

2.2.10 Five types of arrival structure were identified as potential concepts across the LTMA airports. These include optimised versions of current arrival structures. For a structure to be considered 'optimised' it would be relocated, reoriented, and set at better altitudes / flight levels to provide the best balance between capacity and fuel-efficient routings for both airport and network. 'Optimised' and 'best' are qualitative assessments by SMEs.

2.2.11 Initial design areas were drafted for each airport – the 'design envelope'. A design envelope is an illustration of the potential area for placement of arrival structures for an LTMA airport. It is not intended to depict an area for the exclusive use of this airport, which would be impractical because most LTMA airport design envelopes overlap significantly with those of other LTMA airports. This will be resolved during Stage 3 development where more detail will be introduced.

2.2.12 In developing the design options for individual airports, it was necessary to consider if this facility could be shared between airports or would be independent, based on traffic volumes and geographical locations. It was determined that any shared facility could only be viable for a higher traffic volume LTMA airport (Heathrow, Gatwick, London City, Stansted, Luton) if combined with a lower traffic volume LTMA airport (Bournemouth, Biggin Hill, Farnborough, Southampton, Southend, Manston & Northolt), or two or more lower traffic volume airports. Two large traffic volume airports could not share a holding facility.

2.2.13 The output from this stage of the development work and early airport engagement was an Arrival Structure Viability Assessment for each airport module. This matrix matches the viability of each airspace structure against each geographical location. High-level qualitative reasoning is captured in 'Viability Comments' for both the structure and geographical aspects. This provides a holistic viability assessment for each airport of the potential concept options. This was systematic, methodical, and consistent across all airports. There were 210 concept design options at this stage.

2.3 Engagement Activity

2.3.1 NERL then undertook formal engagement with sponsor airports and other stakeholders, many of which had conflicting requirements. All were invited to attend a briefing session, which presented all network and each airport's concept options, and the viability assessments for each. There were 10 online live briefing sessions held over a period of 2 weeks; stakeholders were asked to consider the

[5] 'Radical options' are mentioned in the airspace change process document CAP1616. In this proposal, 'radical' solutions are those considered extremely challenging from a technical, operational, or safety point of view. The proposed Switch Merge concept is considered to be a radical solution as it has never been done in the UK or Europe before and we used it to explore the parameters for feasible options.

design concepts against our design principles. 74 individuals attended the briefings, representing 45 stakeholder organisations. See Table 3 for attendee list.

2.3.2 A video of the briefing, copy of the engagement presentation and a feedback form was sent to all stakeholders, irrespective of whether they attended a briefing, with a 4-week response time. Stakeholders were sent reminder emails: two weeks into the response period; with one week to go, and on the final day, if they hadn't responded. This engagement material was sent to 243 stakeholders, across 142 organisations.

2.3.3 Feedback was received from 26 organisations, as shown in Table 3. Responses were reviewed and assessed to identify themes, for each module and for common themes across the project.

2.3.4 The feedback has informed and shaped the concept design options for the network and the airports. This includes revised design envelopes to reflect feedback on the geographic viability assessments, and some additional design options developed for the airport arrival structure viability assessments.

Organisation Type	Briefing Attendees 74 representatives from 45 organisations:	Feedback Responses 26 responses from organisations:
Aircraft Operators	18 representatives from: American Airlines, British Airways, Delta, easyJet, FedEx, Flybe, Jet2, KLM, Ryanair, TUI Airline, Virgin Atlantic	7 feedback responses: British Airways, Delta, Etihad Airways, easyJet, Loganair, Ryanair, United Airlines
Airports (FASI)	26 representatives from: Biggin Hill, Bournemouth, Farnborough, Gatwick, Heathrow, London City, Luton, Manston, Northolt, Southampton, Southend, Stansted	12 feedback responses: Biggin Hill, Bournemouth, Farnborough, Gatwick, Heathrow, London City, Luton, Manston, Northolt, Southampton, Southend, Stansted
Airports (other)	3 representatives from: Liverpool, Manchester, Bristol Airport	0 feedback responses
ANSPs	9 representatives from: DSNA (France), EUROCONTROL Maastricht, LVNL Netherlands, Ports of Jersey, Skeyes (Belgium)	0 feedback responses
CFSPs / Manufacturers	8 representatives from: Jeppesen / Boeing, Rockwell Collins Aerospace, Lufthansa (LIDO), NAVBLUE, Thales	3 feedback responses: Jeppesen / Boeing, Lufthansa, Thales
MoD	2 representatives from: 78 Squadron Swanwick Mil, DAATM	1 feedback response: DAATM
NATMAC	7 representatives from: Airspace4All, ARPAS, BALPA, BGA, BHA, UK Flight Safety Committee	3 feedback responses: Airspace4All, AOPA, BGA
Policy	2 representatives from: ACOG	0 feedback responses

Table 3 Summary of Stakeholder Engagement Activity & Feedback Responses

2.3.5 Feedback specific to the network or airport design options is described in the relevant module sections. In those sections, we show how this feedback has informed the design options for the network / each airport (including the early rejection of unviable concepts); with some design envelopes and viability matrices being revised. This is the 'you said, we did'.

2.3.6 Feedback which is non-specific and relevant to the project as a whole is presented in the LTMA Design Development Section 4.1.8, with a description of how this has influenced design considerations.

2.4 Subject Matter Expert – concept development

2.4.1 Design development by SMEs continued throughout the engagement period, and some further design options were developed / removed as a result, as detailed in each relevant module.

2.4.2 We engaged with stakeholders on 'Holds Further Out' as one of the five arrival concepts (see Section 5). However, at this stage it was assessed by SMEs that this concept, without an interim delay absorption mechanism (e.g. Point Merge, Trombone), would be unviable. In the event of disruption, the extended distance from the hold would create increased controller workload and complexity compared to today. Compared with the baseline, the extended distance from the hold(s) is also assessed to reduce overall resilience (due to flight time between hold and runway significantly increased). It would also reduce capacity (fewer holding levels, larger holding pattern 'racetrack' dimensions at higher levels that would be more likely to conflict with other network flows). This concept would therefore not align with the Design Principles Operational Resilience (DP1) or Operational Capacity & Efficiency (DP8). All design options using the 'Holds Further Out' concept were removed at this stage.

2.4.3 We also engaged with stakeholders on the concept of 'Trombones' as a suitable arrival structure. As the design options have developed through this stage, SMEs have determined that whilst Trombones do provide a sequencing function this would be less effective at network levels than other options. It also does not provide sufficient delay absorption above 7,000ft, and requires a substantially larger amount of airspace than other options at the higher levels covered by this ACP. A similar concept may be more viable at lower altitudes (covered by airport ACPs for instance), and NERL would work with sponsors to facilitate the connectivity to those structures as needed. Therefore, all design options using the 'Trombone' concept wholly contained above 7,000ft as the primary arrival structure were removed at this stage.

2.4.4 After this engagement and subsequent design development, there were 115 design options (see Table 28 on page 45), which were taken forward to Design Principle Evaluation stage. This is our Comprehensive List.

2.5 Design Principle Evaluation

2.5.1 To ensure the design options could be evaluated against the design principles in a fair and consistent manner, pre-determined criteria were established by SMEs for each DP against which the design option could be qualitatively assessed.

2.5.2 Each option was evaluated as if it was the only delay absorption structure for that airport. The exceptions to this are Heathrow, Gatwick, and Stansted, which SMEs assessed would require more than 1 delay absorption structure to meet demand. See relevant airport module for more details.

2.5.3 In a series of workshops, SMEs reviewed each design option against the DP assessment criteria, and afforded a red (worsens), amber (maintains/worsens), or green (maintains/improves) (RAG) status to each DP, with a supporting rationale. Where the impact of the option was unknown at this stage, the DP was assessed as amber.

2.5.4 Each module also has a 'Do Nothing' option which has been evaluated, even if that option is not viable, in accordance with CAP1616 para E21.

2.5.5 To assist with an accurate DPE, two DPs were split into more than one part:

- DP1 – Operational Resilience. The SMEs' description of resilience changed when considering the network compared to an arrival structure. Network resilience focused on the ability to avoid weather, whereas arrival structure resilience focused on delay absorption and recovery from unplanned runway closures or other disruption. For this reason, this DP has been split into three criteria, one applies to the network and two apply to the arrival structures.
- DP8 – Capacity & Efficiency: this DP has been separated into two parts: capacity (traffic volume) and efficiency (ATCO workload) as these were assessed to be independent factors.

2.5.6 For transparency, all parts of the split DPs are included in the DPE, not just an overall RAG status. Each part has the same weighting as any other similar priority DP. Where possible all RAG criteria have been applied consistently across the network and arrival structures, except for DP1 as described.

2.5.7 DP10 assesses the AMS. The strategic vision of the AMS is to: "deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace" (AMS, page 5). Assessing DP10 (in accordance with the AMS) required additional methodology to assess

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accurately and consistently. Airspace modernisation must meet the strategic AMS objectives – "the ends" (AMS Chapter 2). To determine compliance with DP10, option concepts were assessed against these.

2.5.8 "The ends" (safety, integration of diverse users, simplification, and environmental sustainability) closely align with DP0, DP1, DP3, DP6, DP7, DP8 and DP9. The cumulative assessment for these DPs was therefore used to determine the RAG status for DP10 (using the methodology shown in Table 4). Their reference to the AMS is noted in the 'Priority' column of the DPE, alongside that DP's priority as agreed in Stage 1.

DP10 outcome	Criteria for DP0, DP1, DP3, DP6, DP7, DP8 and DP9
Red	DP0 (Safety) is red OR 2 other DPs are red
Amber	All other colour combinations not covered by Red or Green
Green	2 DPs are green and 0 are red OR 3 DPs are green and 1 is red

Table 4 - AMS Assessment Criteria

2.5.9 Other than safety, the priority of the DP was not considered when assessing the AMS.

2.5.10 There are eleven DPs, but as described in 2.5.5, there are twelve assessments for the network and thirteen for the arrival structures.

2.5.11 An overall accept / reject criteria, was applied to each option as shown in Table 5, based on the DP priority and the RAG status. Options which passed for Priority A DPs, were then assessed on the Priority B DPs, then the Priority C DPs. Two reds would reject B or C priority DPs; this reflects the smaller number of Priority C DPs.

DP Priority	Criteria for Rejection Status
A	1 red OR 1 amber
B	2 reds
C	2 reds

Table 5 - Accept / Reject Criteria

2.5.12 The same methodology was applied to all network and arrival structures.

2.5.13 During the assessment, any option which was described as 'maybe shared' may or may not be shared, and therefore, was assessed as an independent facility per airport. Any option described as 'shared' would only be implemented as a shared facility between airports. 'Maybe shared' and 'shared' design options were therefore evaluated using this context.

2.6 Initial Options Appraisal

2.6.1 The purpose of the IOA is to consider the shortlist of airspace design options which have progressed through the DPE, to provide comparisons of each option via qualitative assessment against the baseline.

2.6.2 As noted in paragraph 2.2.5, it would be disproportionate to attempt to conduct quantitative analysis at this early stage. These assessments are therefore based on qualitative SME input, informed by stakeholder feedback, to ensure the options are appraised in a fair and unbiased manner. We describe broadly the expected scale of impact for each option.

2.6.3 During the Initial Options Appraisal (IOA), any option which was described as 'maybe shared' may or may not be shared. For the IOA, each 'maybe shared' option was appraised as both an independent facility and a shared facility where relevant, consistent with 2.2.12. Any option described as 'shared' would only be implemented as a shared facility between airports.

2.6.4 The following assumptions are made in the Initial Options Appraisal:

- It is more efficient to fly at a higher altitude than a lower one.
- The quantity of fuel burnt is proportional to the distance flown. i.e., increased track miles will result in increased fuel burn.
- Greenhouse gases emitted are directly proportional to fuel burnt, hence GHG emissions are also proportional to the distance flown.
- Continuous Descent Operations (CDO) and Continuous Climb Operations (CCO) improvements are desirable.

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3. Design Option Development (Baseline)

3.1 Current Airspace

3.1.1 This section describes air traffic control and geographical considerations and constraints for the current (baseline – 'Do Nothing') option. It complements the Design Principles and provides additional context.

3.1.2 The LTMA is a designated area of controlled airspace surrounding multiple airports with a high volume of traffic. Within and around the LTMA is an ATS route structure, which includes routes of varying PBN standards that follow the original locations of the, now obsolete, ground based navigational aids (Figure 2, left diagram). The route structure is made up of SIDs, STARs and ATS routes.

3.1.3 The legacy requirement to utilise these has also led to sub-optimal routes that often converge onto specific points. Routes of a lower PBN standard are also often not deemed separated requiring tactical intervention through vectoring which increases controller workload. The existing design results in environmental inefficiencies and limits capacity within the airspace.

3.1.4 A baseline radar density plot was compiled using one week of traffic data from August 2019, showing all traffic between FL70-FL245[6] (Figure 2, right diagram). This is representative of typical summer traffic patterns where traffic volumes are recovering following the COVID-19 impact on aviation.

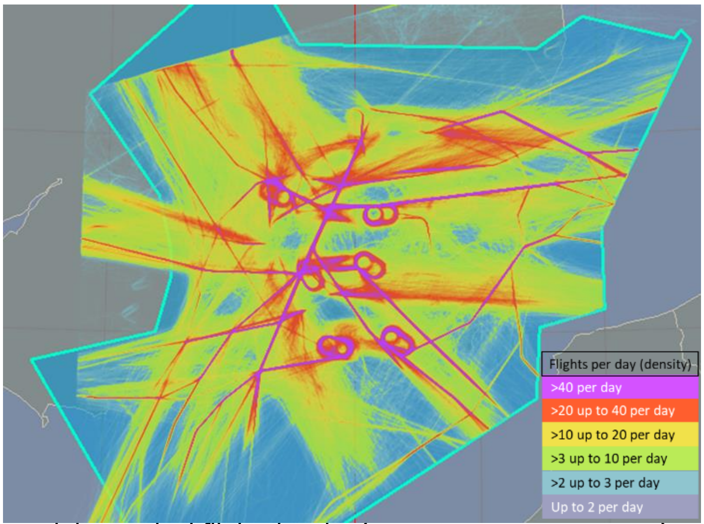


Figure 2 Left: Lower ATS routes structure, Right: Typical flight density (FL70-245, Aug 5-11 2019)

3.1.5 The density plot shows the key traffic flows for traffic in, out, and overflying the LTMA, as well as the holding facilities most utilised.

[6] This is pre-Farnborough ACP, pre-Luton Arrivals ACP changes, does not include Northolt data as its runway was closed during this period, and Manston was not operational.

3.2 Typical air traffic movements and aircraft types: 2019

3.2.1 In 2019 (pre COVID-19) approximately 1.8 million flights transited the airspace impacted by this change. Table 6 shows the distribution of flights across the FASI airports, other LTMA airfields, and overflights[7].

Airport	Arrivals	Departures	Total Movements[8]	% LTMA traffic
Biggin Hill	8,617	8,576	17,193	1%
Bournemouth	6,382	5,919	12,301	1%
Farnborough*	15,408	15,435	30,843	2%
Gatwick	142,457	142,451	284,908	16%
Heathrow	239,058	239,021	478,079	27%
London City	42,363	42,077	84,440	5%
Luton*	70,441	70,474	140,915	8%
Manston	N/A	N/A	N/A	N/A
Northolt*	988	969	1,957	>1%
Southampton	17,816	17,778	35,594	2%
Southend	11,588	11,235	22,823	1%
Stansted	99,223	99,294	198,517	11%
Other LTMA airfields	11,152	12,233	23,385	1%
Overflights			439,066	25%
Total	**665,493**	**665,462**	**1,770,021**	**100%**

Table 6 Breakdown of LTMA traffic impacted by the proposed change

*Farnborough was subject to an ACP implemented Feb 2020; Luton was subject to AD6 ACP implemented in Feb 2022; neither were expected to impact traffic levels. Northolt had a runway closure for 6 months in 2019 so traffic numbers are reduced.

3.2.2 Analysis of the aircraft types across the LTMA (Table 7) showed the most common aircraft category to use this airspace in 2019 were medium jets (67%). This includes twin-jet aircraft such as Airbus A320 or Boeing 737/738.

Aircraft Type	% LTMA traffic
Jet Small	7%
Jet Medium	67%
Jet Heavy / Upper / Super	19%
Piston / Prop / Turboprop	7%

Table 7 Aircraft type using LTMA

3.2.3 Heavy jets comprise 19% of all traffic, this includes heavy twin-jet aircraft such as Boeing 777/787 and super-heavy four-jet aircraft such as Airbus A380.

3.2.4 Other aircraft types using this airspace are piston/turboprops such as the Bombardier DH8D (Dash-8) (7%) and small jets (7%) such as Challenger 350.

3.2.5 Traffic mix for each airport is described in the airport modules.

3.2.6 Table 8 shows the Top 10 carriers which utilise this airspace, based on 2019 data.

3.2.7 About 75% of traffic using this airspace arrives or departs an LTMA airfield; 25% overflies the airspace.

[7] This is based on CFMU actual data for 2019; this may vary from airport data.

[8] An airport 'movement' is counted when an aircraft lands or takes off.

Operator	Movements	Overflights	Total	% LTMA traffic
British Airways	407,249	924	408,173	23%
easyJet	200,389	36,581	236,970	13%
Ryanair	153,433	66,199	219,632	12%
Flybe[9]	40,499	35,443	75,942	4%
Jet2	12,231	39,655	51,886	3%
TUI	18,974	23,837	42,811	2%
KLM	12,455	16,646	29,101	2%
WizzAir	26,072	1,600	27,672	2%
Air France	4,356	20,041	24,397	1%
Virgin	21,004	7	21,011	1%

Table 8 Top 10 Carriers using LTMA airspace (2019 data)

3.3 LTMA Arrivals

3.3.1 Arrivals into the LTMA airfields follow published STARs to transition from the ATS route network to the published holds listed in Table 9.

3.3.2 This is based on data from the UK's Aeronautical Information Publication (AIP), December 2022.

Airport	Hold	STARs	Associated ATS Routes
Farnborough[10]	PEPIS	CPT 1P, NOTGI 1P, ABSAV 1P	Q63, N859, L179, L980, N20
	VEXUB	SOKDU 1V, KATHY 1V, ELDAX 1V, CPT 1V	Q63, N859, L179, L980, P83, N20, M8, N17
Gatwick	TIMBA	BARMI 1G, TEBRA 2G, KONAN 2G, NEVIL 1G, KUVAV 1G	P7, Y4, Q63, L610, L607, M189, G27, Z273, (U)T421
	WILLO	OTMET 1G, VASUX 1G, DISIT 1G, KIDLI 1G, ABSAV 1G, BEDEK 1G, GWC 1G	N17, (U)P88, L982, L151, N859, L980, P2, Y8
Heathrow[11] / Northolt	OCK	OTMET 1H, ROXOG 1H, BEDEK 1H, HAZEL 1H	N17, (U)P87, L982, P2, L620
	BIG	ALESO 1H	T420
	BNN	NUGRA 1H, HON 1H	(U)Y53, Q36, Q38, L15, L10, L612
	LAM	BARMI 1H, LOGAN 2H	P7, L608, L980
London City/ Biggin Hill	JACKO	XAMAN 1C, SUMUM 1C, SILVA 1C, LISTO 1C, HON 1C	L608, Q63, L980, (U)Q4/Z197, UL612/L10
	GODLU	KATHY 1C, SAM 1C, BEDEK 1C, AVANT 1C, NEVIL 1C, SOVAT 1C, KONAN 1C	L980, L620, L89, P2, M189, L9, L613
Luton	ZAGZO	UNDUG 1N, BEDEK 1N, RINIS 1N, TOSVA 1N, XAMAN 1N, TELTU 1N, LISTO 1N, BARMI 1N, FINMA 1N, DET 2A, SILVA 1N, LOGAN 2A	M40, Y6, L980, (U)M733, (U)M185, N17, L982, (U)N6, L612, P18, Q4, (U)Y124, Z197, P7, P2, L15/M605, N57, M183, Q41, L608
Southampton / Bournemouth	SAM	BUGUP 1S, THRED 1S, ELDAX 1S, UMBUR 2S, CPT 1S, COWLY 1S	L8, Y322, Q41, Y110, N20, M8, M40, Q63, Q41
Southend	GEGMU	SUMUM 1S, XAMAN 1S, KATHY 1S, SAM 1S, NEVIL 1S, SOVAT 1S	L980, L620, M189, L613, L608, Q63
	SPEAR	LISTO 1S, FINMA 1S, SILVA 1S	L15, M605, L612, P18, Q4, (U)Y124, Z197
Stansted[12]	ABBOT	RINIS 1A, TOSVA 1A, XAMAN 1A, BARMI 2A, DET 2A, LOGAN 2A	M733, Y8, L612, P18, Q4, (U)Y124, Z197, P2, M605, L89, L980
	LOREL	TELTU 1L, BANVA 1L, LISTO 1L, BEDEK 1L, SILVA 1L, FINMA 1L, AVANT 1L	P7, N57, L608, L980

Table 9 List of LTMA holds and arrival route connectivity (Dec 2022)

[9] The original Flybe went into administration in March 2020 and several of their routes were taken over by other carriers. The name Flybe was purchased and relaunched later in the same year, and went into administration for a second time in January 2023.

[10] The routes shown also apply to Blackbushe, Dunsfold, Fairoaks, Lasham and Odiham.

[11] The routes shown also apply to Denham.

[12] The routes shown also apply to Cambridge.

3.3.3 Figure 3 is a pictorial representation of Table 9, which demonstrates the complexity of this airspace for airport arrival procedures.

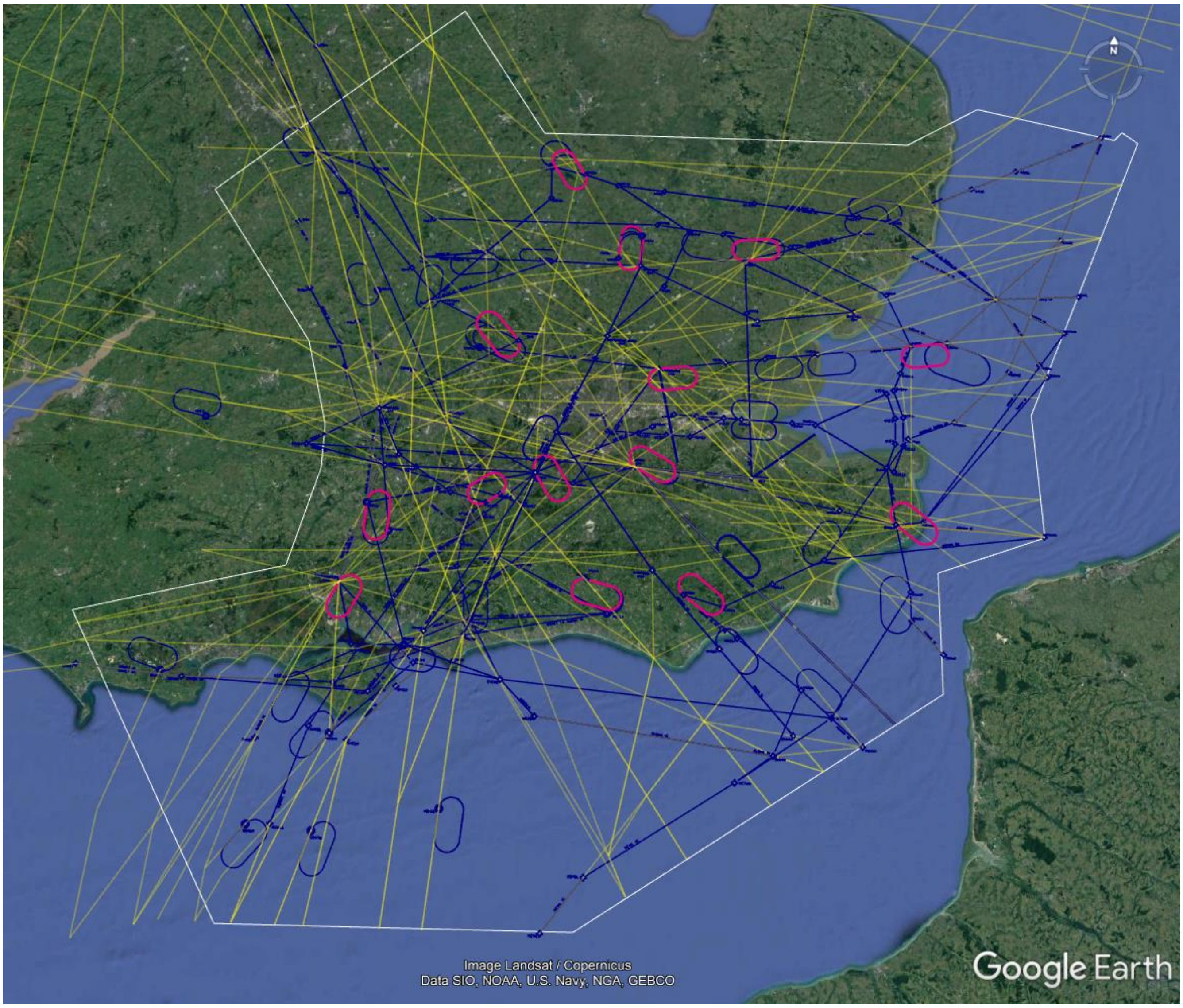


Figure 3 LTMA Airport STARs, terminal holds and ATS route connectivity[13]

Key:

STARs including en-route holds

ATS routes

Terminal Holds

[13] This diagram shows ATS routes including the LD1.1 ACP changes implemented in March 2023 described in paragraph 1.4.7

3.4 LTMA Departures

3.4.1 Departures from six main LTMA airfields follow published SIDs to connect the airport to the ATS route network, as listed in Table 10 and shown in Figure 4.

Airport	SIDs	Associated ATS Routes
Farnborough	GWC (2L/2F)	N859
	HAZEL (2L/2F)	L620
Gatwick	LAM (5P/5W/6M/6V/1Z)	N57, L10, N601
	TIGER (3M/3V/1X)	N57, L10, N601
	DAGGA (1M/1V/1X)	L620
	FRANE (1M/1V/1P/1W/1Z)	M604
	WIZAD (4M/4V/1X)	L9, L10
	MIMFO (1M/1V)	Y312
	DVR (2P/2W)	L9, L10, L18
	ODVIK 2Z	Y311
	HARDY (5M/5V/1X)	M605
	BOGNA (1M/1V/1X)	L612, Y47
	SAM (3P/3W)	Q41, L620, N621, N866
	IMVUR 1Z	N63
	SFD (5M/5V/9W/9P/4Z/1X)	M605, Y47
	KENET (3P/3W)	L9, N14
	NOVMA (1M/1V/1Z)	L620
Heathrow	UMLAT (1F/1G)	T418
	ULTIB (1J/1K)	T418
	BPK (7F/7G/6J/5K)	M185, L620
	DET (2F/2G/1J/1K)	L6, Q70
	MODMI (1J/1K)	M185
	MAXIT (1F/1G)	Y803
	GOGSI (2F/2G)	N621
	GASGU (2J/2K)	N866
	CPT (3F/3G/5J/4K)	Q63
London City	BPK (1A/1H)	N57, N601
	SOQQA (1A/1H)	M87
	ODUKU (1A/1H)	M84
	SAXBI (1A/1H)	N27
Luton	OLNEY (2B/2C)	T420, N57
	MATCH (2B/2C/3Y)	Q295
	DET (8B/7C/3Y)	L6, Q70
	CPT (4B/7C)	Q63, N859, Y321, N866
Stansted	DET (2R/2S/2D)	L6, Q70, M604
	CLN (9R/5S/2E)	M84, L620, L608
	NUGBO (1R/1S)	M183
	UTAVA (1R/1S)	Q75

Table 10 List of current LTMA SIDs and the connected ATS routes

3.4.2 Figure 3 is a pictorial representation of Table 10, which demonstrates the complexity of this airspace for airport departure procedures.

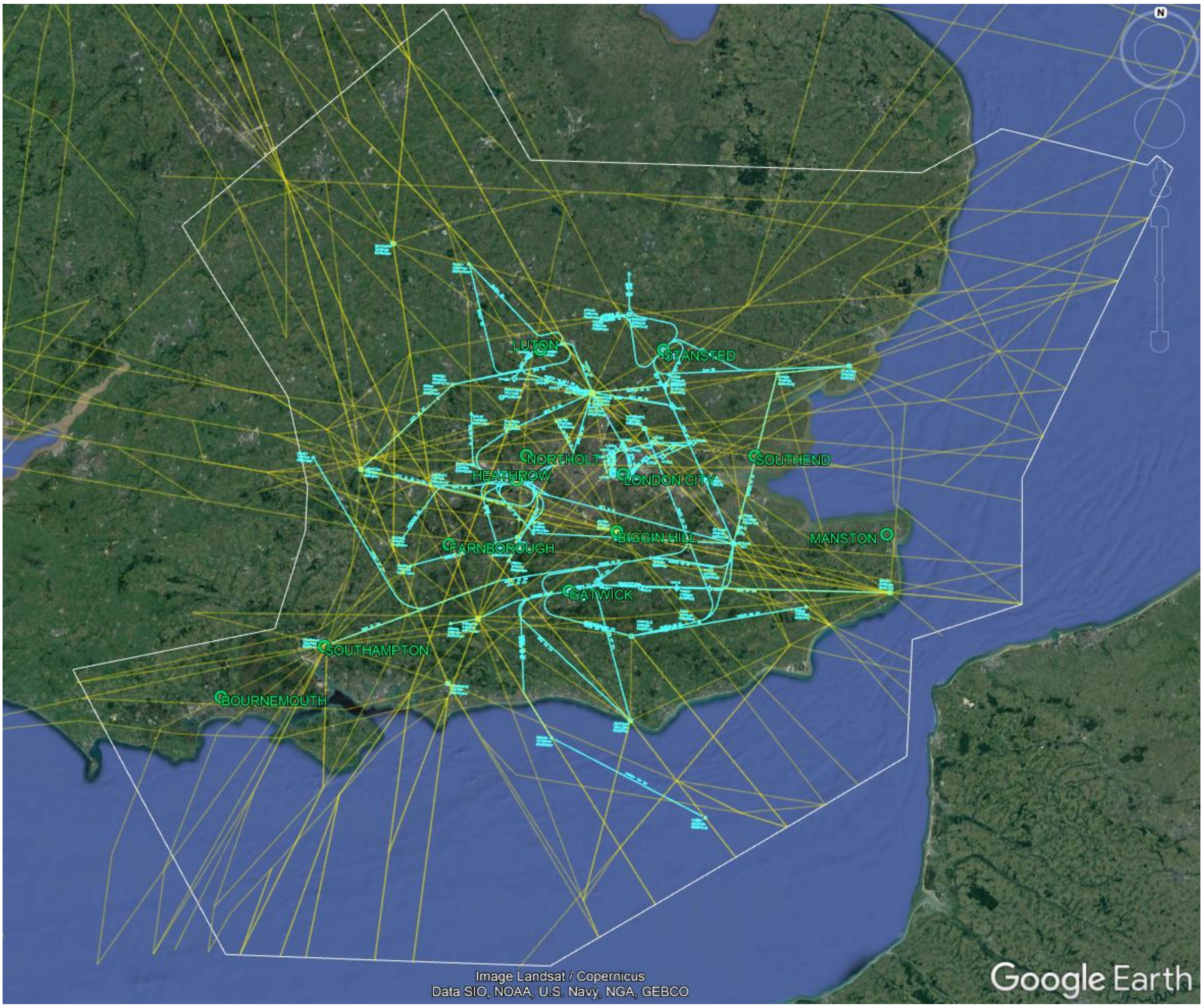


Figure 4 LTMA Airport SIDs and ATS route connectivity

Key:

SIDs

ATS routes

3.4.3 Figure 5 is a combination of Figure 3 and Figure 4, illustrating the complexity of current arrival and departure procedures and ATS routes within the LTMA.

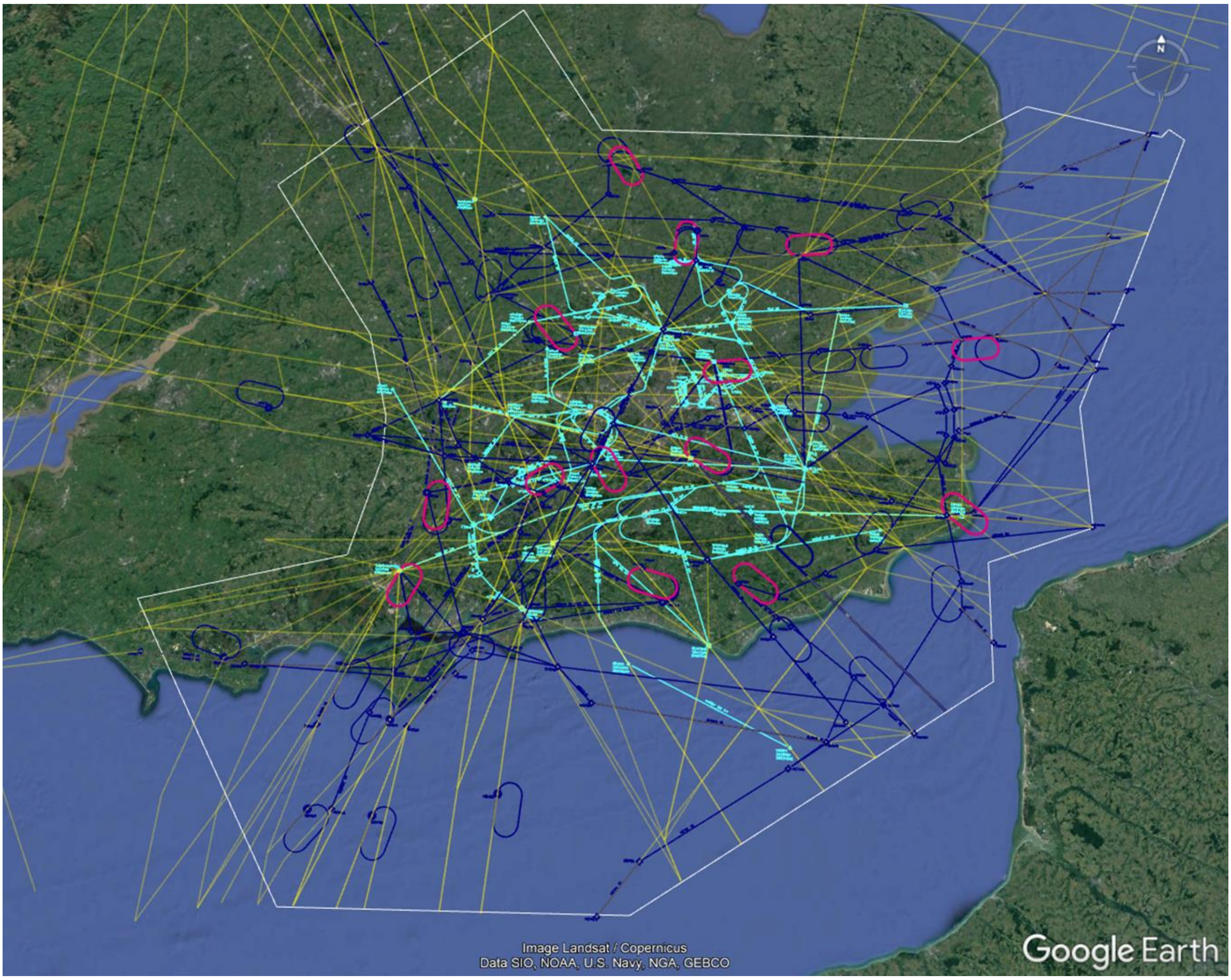


Figure 5 LTMA Airport STARs, SIDs and ATS route connectivity

Key:

STARs including en-route holds

ATS routes

Terminal holds

SIDs

3.4.4 Figure 6 shows a radar density plot of LTMA traffic for a typical busy summer week (August 5-11th 2019). The arrows illustrate the broad swathes of traffic routes, with the prevalent traffic flows shown[14].

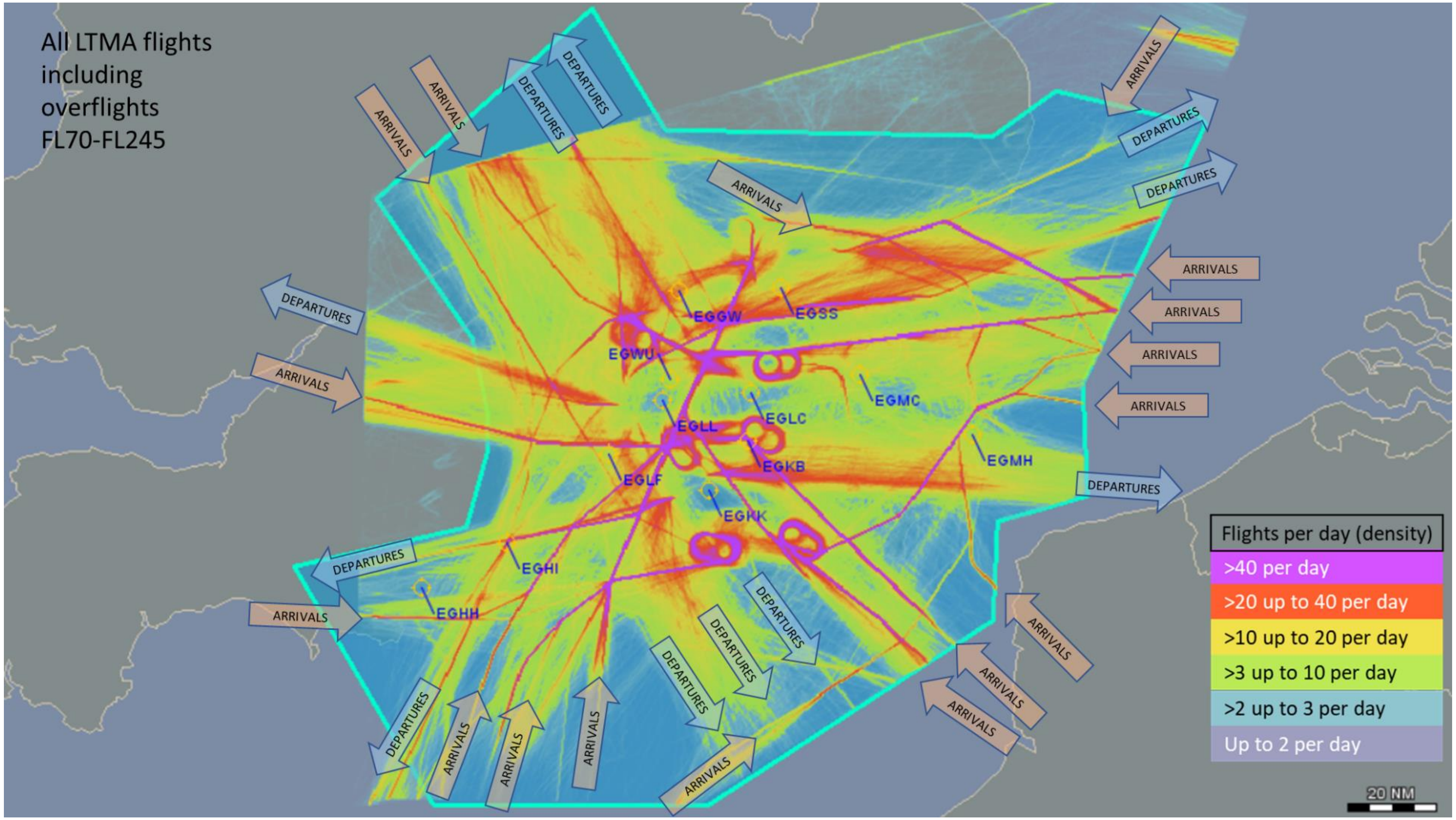


Figure 6 Prevalent traffic flows in the LTMA (illustrative schematic) - all traffic (5-11 August 2019) FL70 - FL245

[14] It is a working assumption of this ACP that prevalent traffic flows would not change, neither would international-boundary Coordination Points known as COPs.

3.5 Constraints

3.5.1 Several existing airspace structures restrict the size and/or location of design options. These structures are shown in Figure 7, and have been considered in the concept design options.

3.5.2 As NERL progresses beyond the Initial Options Appraisal phase, any remaining options which may encroach upon extant fixed airspace structures will be subject to further engagement with the relevant stakeholder organisation to determine whether a feasible solution can be reached in Stage 3.

3.5.3 This map highlights regions or areas of the airspace within which NERL considers that making changes or alterations will need additional consideration:

- Red segments are areas of airspace where changes may be exceptionally challenging to make.
- Orange segments are areas where changes may be challenging to make.
- Yellow segments are areas where the provision of air traffic services is delegated to the UK from neighbouring states, within which the airspace design remains the responsibility of the parent state and is outside of the scope of this proposal. This need to be considered through the design process.
- Purple segments are areas of airspace that currently have unusual activity that need to be taken into account through the design process.

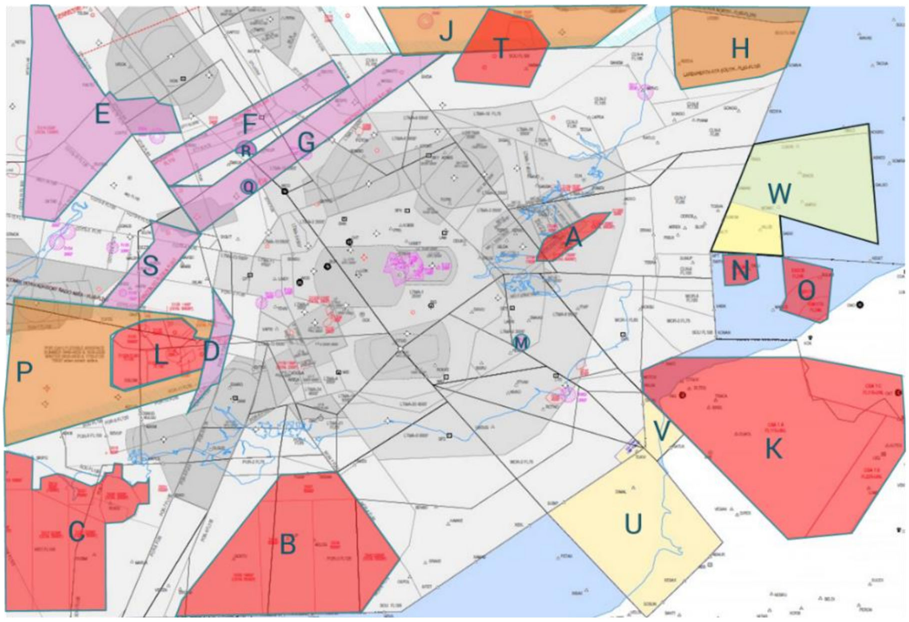


Figure 7 Current constraints for airspace design

Red Segments	Orange Segments	Purple Segments
A – Shoeburyness Danger Area (DA) Complex: time & level dependent	H – Lakenheath Aerial Tactics Area	D – Solent FUA: time dependent
		E – Cotswold FUA: time dependent
B – Portsmouth DA Complex: time & level dependent	J – East Anglia Military Training Area	F – DTY Radar Corridor FL100/110
		G – WCO Radar Corridor FL230/240
C – Plymouth DA Complex: time & level dependent	P – Temporary Reserved Area 002	M – Headcorn Paradrop site
K – CBA1 (Military Training Area)	**Yellow Segments**	Q – Weston-on-the-Green Paradrop site
L – Salisbury Plain DA Complex: time & level dependent	U – Area of ATS delegation from France	
N – Belgium DA: time dependent	V – Area of ATS delegation from France	R – Hinton Paradrop site
O – Belgium DA: time dependent		
T – USAFE Lakenheath and Mildenhall local area	W – Area of ATS delegation from the Netherlands	S – Swindon Radar Corridor FL230/240

Table 11 Airspace Constraints within the LTMA baseline

3.6 Tranquillity Impacts

3.6.1 Within the lateral limits of the LTMA change there are Areas of Outstanding Natural Beauty (AONB) and National Parks (NP). CAP1616 states that where practicable, it is desirable that airspace routes below 7,000 ft should seek to avoid flying over AONBs and NPs.

3.6.2 This change is not intending to alter flightpaths below 7,000ft and therefore AONB/NPs do not need to be considered in the options development. Should it transpire that an option will impact on an AONB/NP below 7,000ft, the relevant stakeholder(s) will be informed and engaged with.

National Parks	
New Forest	South Downs

Areas of Outstanding Natural Beauty			
Chichester Harbour	Chilterns	Cotswolds	Cranborne Chase & West Wiltshire Downs
Dedham Vale	Dorset	High Weald	Isle of Wight
Kent Downs	North Wessex Downs	Suffolk Coast & Heaths	Surrey Hills

Table 12 List of National Parks (NP) and Areas of Outstanding Natural Beauty (AONB) in the region

3.7 Biodiversity Impacts

3.7.1 Airspace changes are unlikely to have an impact on biodiversity because they do not normally involve changes to ground based infrastructure (habitat disturbance).

3.7.2 No such ground-based infrastructure changes are associated with this proposal, therefore this proposal is not predicted to impact biodiversity.

3.7.3 Biodiversity was not part of a Design Principle in Stage 1. During engagement, stakeholders did not identify biodiversity concerns in any specific region.

3.8 Introduction and Release of Controlled Airspace

3.8.1 Some options may require a change to the volume or classification of controlled airspace (CAS). Where possible CAS that is no longer required will be released. This could serve to off-set, in part, any new CAS that may be required.

3.8.2 At this stage, we have not determined the extent of any CAS changes (whether more is required, or whether it can be returned to Class G). Should there be a situation where the base of CAS could be raised, it is possible that a base below 7,000ft (e.g.5,500ft or FL65) could be raised, thereby releasing CAS (converting it to uncontrolled Class G airspace). This would be relevant only for CAS volumes that are not associated with an airport. Those associated with an airport would be for the airport to release if appropriate.

3.8.3 NERL considers this to be analogous to the SARG policy Reduction in Notified Hours or Disestablishment of Airspace Restrictions, which is a Level 0 ACP process. The release of CAS will only be considered where there is existing Class G airspace available for GA traffic to currently use below CAS. Therefore, any release of CAS will result in an increase in airspace volume of existing Class G airspace.

3.8.4 NERL considers that the release of airspace, under this condition, will have a negligible impact on the number of aircraft using the airspace. Therefore, the release of CAS will only deliver positive impact to our stakeholders by providing a greater volume of airspace for GA traffic to fly within. This could also lead to a potential reduction in the noise impact for stakeholders on the ground as aircraft will be able to elect to fly at a higher altitude.

3.8.5 NERL therefore considers the release of CAS will not compromise the arguments for scalability within this ACP as this would only deliver positive benefits. NERL does not consider it proportional to attempt an analysis of potential GA use or impact of this use of released CAS as it is not possible to predict the GA utilisation of network-level airspace.

3.9 Forecasts

3.9.1 The long-term impacts of COVID-19 on the aviation industry are yet to be fully understood, though a recovery is underway. The EUROCONTROL STATFOR October 2022 Base forecast model presents an anticipated growth in traffic for the LTMA change proposal area until 2027. From 2028, traffic is forecast using a long—term average growth rate of 1.9% (EUROCONTROL STATFOR October 2022 Extended forecast).

3.9.2 We expect the changes to the LTMA to be implemented over at least 3 deployments, the earliest deployment expected in 2027 (aligned with the Masterplan), with subsequent deployments to follow. Table 12 shows actual traffic counts, from the representative baseline year (2019) up to 2022 (see also paragraph 2.1.4). The forecast model grows traffic from the most recent full year (2022). From 2023, the traffic forecast shows the predicted traffic count, including the implementation year 2027 and for the 10-year period post implementation.

3.9.3 At Stage 3, NERL will separate the traffic forecasts for each deployment; specific forecasts will be provided for each relevant deployment area (see also paragraph 1.2.2 on p.4).

3.9.4 It is assumed the general mix of aircraft operating within the LTMA will remain the same as the baseline; NERL does not expect this ACP to cause a change in the general fleet mix.

Year	LTMA Arrivals	LTMA Departures	LTMA Overflights	Total Traffic
Actual traffic levels				
2019	665,493	665,462	439,066	1,770,021
2020	267,757	267,487	171,615	706,859
2021	256,804	257,042	187,008	700,854
2022	533,229	532,976	381,906	1,448,111
2023	605,005	604,718	433,313	1,643,036
2024	654,762	654,452	468,950	1,778,164
2025	670,646	670,328	480,326	1,821,300
2026	683,950	683,625	489,854	1,857,429
First implementation year				
2027	695,355	695,024	498,022	1,888,401
2028	708,323	707,986	507,310	1,923,619
2029	721,533	721,190	516,771	1,959,494
2030	734,989	734,640	526,408	1,996,037
2031	748,696	748,341	536,225	2,033,262
2032	762,659	762,297	546,225	2,071,181
2033	776,882	776,513	556,412	2,109,807
2034	791,370	790,994	566,789	2,149,153
2035	806,129	805,746	577,359	2,189,234
2036	821,163	820,773	588,126	2,230,062
First implementation plus 10 years				
2037	836,477	836,080	599,094	2,271,651

Table 13 Forecast growth of traffic impacted by this change for 10 years post-implementation

3.9.5 This table illustrates the LTMA network forecast. Each of the airport modules contains recent actual traffic movements 2019-2022 for context, however each airport sponsor also has its own growth aspirations and forecasting assumptions.

3.9.6 At this early stage it would be disproportionate to attempt to forecast how the LTMA traffic growth would be distributed between competing airports. That detail is expected to be produced for Stage 3 as development continues.

4. Design Option Development: Network Options

4.1.1 This section outlines the Network Design Options which have been developed using the methodology described in Section 2.

4.1.2 The network design options will provide departure connectivity to airport SIDs (or standard departure routes). As described in paragraph 2.2.3 on page 11, runway departure procedures are being developed by the airports, hence there are no specific NERL departure design considerations at this stage.

4.1.3 Arrival connectivity is separated for each airport and further detail is provided in each module.

4.1.4 Initial design development work is conceptual in nature at this stage. Five network options were assessed to be viable and taken forward to engagement with stakeholders (Ref 7).

4.1.5 The feedback we received led to us making design decisions by helping shape and inform our development of these options, including their evaluation against our design principles.

4.1.6 Overall, feedback for the network options indicates stakeholders understand this is complex airspace, and the optimal design will need to balance environment, capacity, flexibility, and efficiency.

4.1.7 Stakeholders provided specific feedback for each network design option, as described in the relevant sections below. As a result of this, two options were not considered viable to progress. No new options were developed at his stage, although some were considered, and the comprehensive list was reduced to three options.

4.1.8 Table 14 shows feedback which is general to the proposed changes, and NERL's response.

Theme	Stakeholder	Feedback ('You said')	Response ('We did')
Coding	Lufthansa Systems	From an FMS coding perspective, all options are fine (network options).	Positive feedback on network options/FMS coding. No action required.
Constraints	BGA	Changes at & above 7,000ft could impact gliding activity due to commercial flights climbing and descending through 7,000ft in these gliding-significant areas: Lasham and routes to/from Lasham to the south through west to north. Parham and routes to the northwest and to the east between Gatwick and the coast Booker, Halton and Dunstable Downs and routes to the southwest through west to north. Gransden Lodge and routes to the southwest through north to east.	These are not considered as constraining airspace structures; however this feedback informs the ATC design team on glider operations. The interfaces at 7,000ft will be considered as the designs progress.
	MoD	Positive to see wider MOD activity considered (areas of complexity/ DAs) in the design envelopes.	Positive feedback on constraints. No action required.
Costings	United Airlines	Concerns that airlines cover the costs of airspace change which benefits drone / space operations.	This ACP is intended to optimise the airspace for commercial operations whilst minimising or positively impacting on other airspace users.
Design Option Development	British Airways	Heathrow and Gatwick should be prioritised over other airports due to traffic demand.	At this stage, no airport is prioritised over another, as we strive for a balanced network-wide design. Stage 3 work will identify prioritisation needs.
	Thales Avionics	For departures, low altitude level-offs (e.g. 6,000ft) is fuel penalising.	Changes are above 7,000ft. NERL will consider this in the design of the departure transitions/connectivity. Low-level changes will be within the airport ACPs.
	easyJet / Heathrow/ Farnborough	Recognise that due to the complexity of the airspace, options are conceptual only at this stage.	Given the complexities of this airspace change and the interdependencies, at this stage we are developing concepts only. During Stage 3, designs will become more detailed ready for consultation.
	United Airlines / Ryanair	Stakeholders are prioritising safety, cost reduction and capacity.	These priorities are shared by NERL and are all addressed within the Design Principles DP0, DP2 & DP8.
	Airspace4All	The design is based on legacy navigation capabilities; this should be reviewed.	The navigation standard of aircraft is outside of our control. Where appropriate, the airspace will be designed to the

Theme	Stakeholder	Feedback ('You said')	Response ('We did')
Design Option Development (continued)			highest appropriate PBN standard, in collaboration with the airports, allowing for the most efficient spacing between routes.
	Airspace4All	Traffic data is not representative of actual traffic data (from CAA) in 2022.	The baseline traffic data comes from NERL's own data as captured in 2019. This could be marginally different from other data sets depending on how the information is sourced (for example flight planned versus actual flights). Radar track pictures are presented as a illustrative snapshots, with associated context supplied. Actual traffic counts for 2019-2022 are included in the section on forecasts (Section 3.9 from page 25).
Engagement feedback	Heathrow/ United Airlines	Acknowledges collaborative engagement and supportive of NERLs work to date.	NERL look forward to continued engagement.
	Biggin Hill	Full engagement is required, specifically for the proposed changes to Gatwick, Heathrow, London City and Southend.	NERL has worked collaboratively with all FASI sponsors throughout the process, including Biggin Hill, and will continue to do so going forward as the ACP develops. Biggin Hill attended the formal Stage 2 engagement briefing and received a copy of the briefing presentation and recording.
GA impacts	AOPA	If any local GA aerodromes within the LTMA seek GNSS approaches how will that impact your plans? How will you accommodate VFR flights within the LTMA?	NERL will be working in collaboration with airport sponsors and the GA to iterate and refine the options throughout the early part of the Stage 3 process so that the full impact of the changes can be fully understood at consultation, this includes the extent and classification of CAS, integration of traffic to and from the network,, as well as IFR transits thought the network.
Policy	Airspace4All	Does ACOG support this proposal? Will feedback be reviewed with them?	ACOG are aware of this FASI ACP, they have had no input into the proposal, and it is not their role to support (or not) the content of any of the FASI proposals. They will not be reviewing the feedback from our engagement, as this is also outside the scope of their role. No action required.

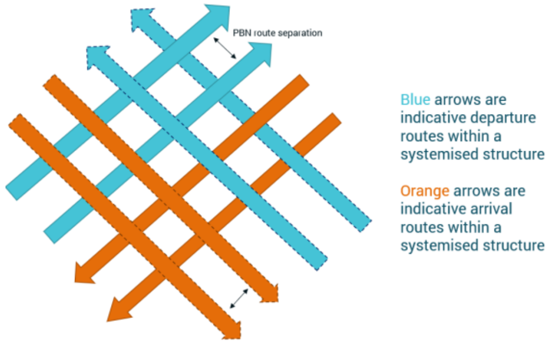
Table 14 General feedback to the proposed changes and NERL response

4.1.9 The three network options were progressed as the Comprehensive List of Network Options to be evaluated against the design principles, as per the methodology described in section 2.5, and presented below.

4.1.10 One network option concept progressed through the DPE stage, Hybrid Systemisation, and this option was progressed to Initial Options Appraisal.

4.1.11 The following pages present a summary of each option, the stakeholder feedback, and how this has influenced the design development. Design Principle Evaluations are presented for each on the comprehensive list, and the Initial Options Appraisal for the progressing option Hybrid Systemisation.

Network Option 1: Highly Systemised

Diagram	Description
	Option 1 is based upon maximum use of systemisation to create a highly structured network. This network would allow aircraft to be safely separated with minimal ATC intervention, using an appropriate standard of PBN. This option is considered optimal for capacity however this option may have a negative impact of fuel burn and CO_2.

Stakeholder Feedback

4.1.12 Overall, stakeholders thought that this design option is feasible and offers predictability for flight planning and for fuel usage. It is likely to reduce ATCO workload. However, it would reduce flexibility and it is likely to have an increased negative environmental impact over other options due to increased track miles, as shown in Table 15.

Stakeholder	Summary of Feedback ('You said')	Response ('We did')
Thales Avionics / Luton Airport / Boeing / easyJet /Stansted	Provides predictability – for flight planning; fuel usage and scheduling	Feedback was used to inform the evaluation of DP1, DP2, DP4 & DP8
Gatwick Airport / Boeing /Manston /easyJet / British Airways / Farnborough	Offers deconfliction by design. Use of technology (PBN) to improve operational efficiency (reduce ATCO workload) and safety	Feedback was used to inform the evaluation of DP0, DP1, DP8 & DP9
Thales Avionics / Luton Airport / Manston / BGA /Delta /British Airways / Bournemouth /Stansted	Environmental impact likely to be greater with increased fuel usage likely / inefficient for the airspace required	Feedback was used to inform the evaluation of DP2, DP3 & DP4
Gatwick Airport / RAF Northolt / AOPA/ Airspace4All/ Southend /Delta / Bournemouth /Stansted / Southampton	Rigidity of design could limit operational resilience / capacity in certain situations	Feedback was used to inform the evaluation of DP1 & DP8
Stansted / BGA /Manston / Luton	Concerns around airspace requirements	Feedback was used to inform the evaluation of DP5 & DP6
Ryanair	Optimises capacity	Feedback was used to inform the evaluation of DP8
Lufthansa LIDO	Highly systemised airspace could create technical issues for flight planners if databases have insufficient storage	Considered in the development of the network options. This is a known issue and will continue to be managed outside this ACP via existing technical forums.

Table 15 Stakeholder Feedback for Network Option 1

4.1.13 Based on this feedback, no changes were made to the design concept. Stakeholders have recognised both the potential benefits and the limitations of this concept, and it was progressed through to the comprehensive list for DPE.

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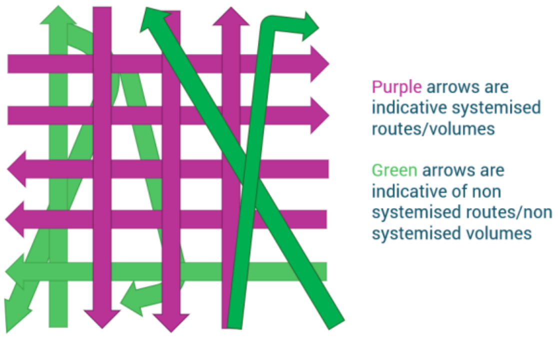
Network Option 2: Hybrid Systemisation

Diagram	Description
	Option 2 is based upon the predominant use of systemisation to create the route network, using an appropriate standard of PBN. Unlike Option 1, some routes may not be wholly separated by design thereby creating a balance between capacity and environmental performance. Where routes are not separated by design, this will be managed tactically, as per today, to ensure a safe and efficient service.

Stakeholder Feedback

4.1.14 Overall, stakeholders thought that this design option is feasible and offers flexibility through tactical intervention. It balances capacity and predictability against environmental performance.

Stakeholder	Summary of Feedback ('You said')	Response ('We did')
Luton / RAF Northolt / Boeing	Provides predictability – for flight planning; fuel usage and scheduling	Feedback was used to inform the evaluation of DP1, DP2, DP4 & DP8
Gatwick / Boeing / Stansted / Farnborough	Offers deconfliction by design. Use of technology (PBN) to improve operational efficiency (reduce ATCO workload) and safety	Feedback was used to inform the evaluation of DP0, DP1, DP8 & DP9
Gatwick / RAF Northolt /AOPA / Southend / MoD / Bournemouth/ Stansted	Flexibility offers operational resilience / capacity in certain situations	Feedback was used to inform the evaluation of DP1 & DP8
Thales / Luton / Gatwick / Manston / MoD / Delta / British Airways / Bournemouth	Offers flexibility with tactical intervention. Balances systemisation and environmental performance	Feedback was used to inform the evaluation of DP2, DP3, DP4 & DP8
Lufthansa LIDO	Highly systemised airspace could create technical issues for flight planners if databases have insufficient storage	Considered in the development of the network options. This is a known issue and will continue to be managed outside this ACP via existing technical forums.

Table 16 Stakeholder Feedback for Network Option 2

4.1.15 Based on this feedback, no changes are made to the design concept. Stakeholders have recognised both the potential benefits and the limitations of this concept, and it was progressed through to the comprehensive list for DPE.

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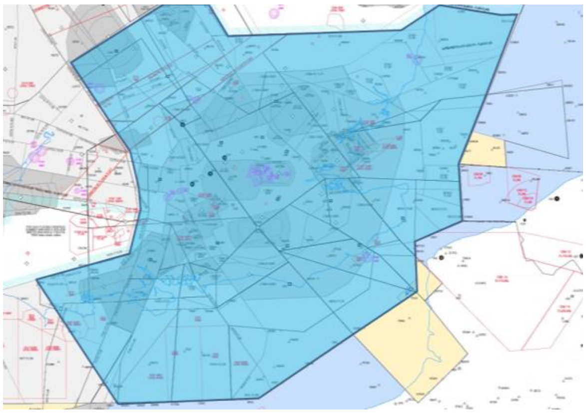
Network Option 3: Do Minimum

Diagram	Description
	Option 3 would retain the general existing ATS route structure. Changes would be the minimum required to facilitate the airports' ACP changes and may also include: • amending routes at the interface with other sponsors' changes, • upgrading routes to greater PBN standards, • adjusting route orientations.

Stakeholder Feedback

4.1.16 Overall, stakeholders thought that this design option is operationally feasible, but would not offer the long-term benefits required by airports and the AMS objectives, in particular for environmental and capacity benefits.

Stakeholder	Summary of Feedback ('You said')	Response ('We did')
Thales / Luton / Gatwick / RAF Northolt / Loganair / Airspace4All / MoD /easyJet / Delta / British Airways /Bournemouth / Stansted / Ryanair	Provides insufficient benefits given the intent and scale of changing the LTMA	This feedback led us to deem the option not viable for further development due to lack of perceived benefits
Luton / AOPA / Stansted	Does not offer improved environment benefits	This feedback led us to deem the option not viable for further development due to lack of perceived benefits
Gatwick / Boeing / Stansted	Does not offer required capacity / efficiency benefits	This feedback led us to deem the option not viable for further development due to lack of perceived benefits
Boeing / Delta	Does not make best use of technology (PBN)	This feedback led us to deem the option not viable for further development due to lack of perceived benefits
Manston	Changes would support airport requirements	Considered in the development of the network options
BGA	Concerns around airspace requirements	Considered in the development of the network options
Lufthansa LIDO	Minimal changes are unlikely to create technical issues for flight planners due to database storage	Considered in the development of the network options

Table 17 Stakeholder Feedback for Network Option 3

4.1.17 Based on this feedback, this concept is not progressed through to the comprehensive list for DPE. Stakeholders have recognised the limitations of this concept, and the feedback from the majority indicates this is not viable for further development.

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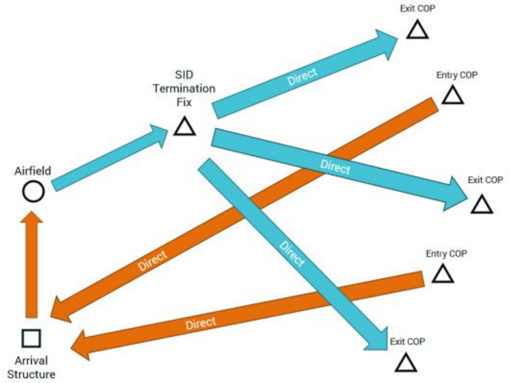
Network Option 4: Direct Route Airspace

Diagram	Description
 (Indicative schematic)	Flight Plannable Direct Routes (DCTs) provide route connectivity in the form of direct routes linking airports' STAR start points and SID end points with the UK airspace boundary, intermediate points or FRA. DCT airspace has no associated PBN standard. This option is considered to be optimal for fuel and CO_2 however this may significantly reduce capacity in the busy LTMA environment.

Stakeholder Feedback

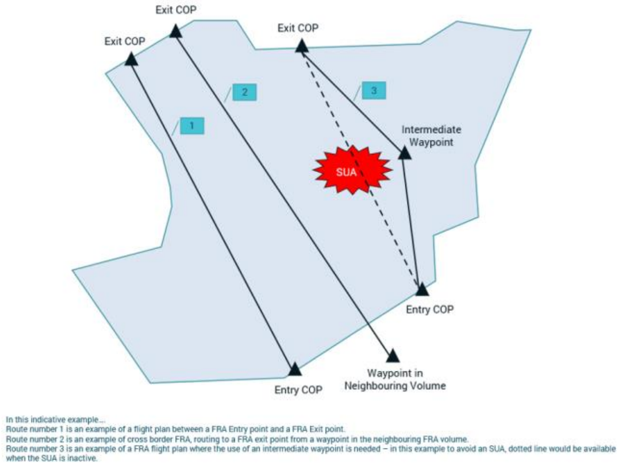
4.1.18 Stakeholders presented mixed feedback on this option. Feedback suggests this concept requires further development to determine the feasibility of this design option in such complex airspace. In particular, environmental and capacity impacts, CAS requirements and limited use of PBN technology are concerns.

Stakeholder	Summary of Feedback ('You said')	Response ('We did')
Thales / Gatwick	Direct Route Airspace combined with Hybrid Systemisation (Option 2) and / or FRA (Option 5) could be a solution for NERL to consider	This alternate suggestion was assessed and determined to not be viable due to differing separation standards and human factors issues which could compromise safety
Thales/ RAF Northolt /Manston / easyJet / Farnborough	Complexity of LTMA and volume of traffic could be challenging for this option	Feedback was used to inform the evaluation of DP0 & DP8
Luton / MoD / Delta / Bournemouth /Stansted	Positive and negative environmental impacts	Feedback was used to inform the evaluation of DP2, DP3 & DP4
Luton / Gatwick /Manston / BGA	Concerns around airspace requirements	Feedback was used to inform the evaluation of DP5 & DP6
Gatwick / Boeing / Stansted	Does not make best use of technology (PBN)	Feedback was used to inform the evaluation of DP9
Boeing / AOPA / MoD / easyJet / Bournemouth / Stansted	Rigid design could limit operational resilience / capacity in certain situations	Feedback was used to inform the evaluation of DP1 & DP8
Lufthansa LIDO	Minimal changes are unlikely to create technical issues for flight planners due to database storage	Considered in the development of the network options.
Delta	Balances separation and efficiencies of direct routes	Feedback was used to inform the evaluation of DP8
BGA	Definition of DRA or FRA above a particular level (32,000?) would alleviate some of the BGA's concerns.	This ACP is predominantly concerned with changes from 7,000ft (FL70) to FL245. See 1.3.6

Table 18 Stakeholder Feedback for Network Option 4

4.1.19 Based on this feedback, no changes are made to the design concept. Stakeholders have recognised both the potential benefits and the limitations of this concept, and it was progressed through to the comprehensive list for DPE.

Network Option 5: Free Route Airspace

Diagram	Description
	Free Route Airspace (FRA) is a specified airspace within which users may freely plan a route between a defined entry point and a defined exit point, with the possibility to route via intermediate (published or unpublished) waypoints, without reference to the ATS route network, subject to airspace availability. Within this airspace, flights remain subject to air traffic control and any structural limitations such as Special Use Airspace (SUA). FRA has no associated PBN standard.

Stakeholder Feedback

4.1.20 Stakeholders presented mixed feedback on this option. Feedback suggests this concept would be very challenging to implement in such complex airspace. In particular, complexity, predictability, environmental and capacity impacts are concerns.

Stakeholder	Summary of Feedback ('You said')	Response ('We did')
Airspace4All / Boeing / Bournemouth / Delta / easyJet / Luton / Manston / Southend / Thales	Complexity of LTMA & volume of traffic could be challenging for this option	This feedback led us to deem the option not viable for further development due to complexity of airspace; this would not meet DP0 and DP8 (safety & controller workload)
Gatwick / MoD / Stansted	Flexibility of design could impact operational resilience / capacity	Considered in the development of the network options
Delta / Gatwick	Reduces predictability, could impact on safety, and does not offer deconfliction by design	This feedback led us to deem the option not viable for further development due to complexity of airspace; this would not meet DP0 and DP8 (safety & controller workload)
Gatwick / RAF Northolt / MoD / Delta / Stansted	Positive and negative environmental impacts	Considered in the development of the network options
Manston / BGA / AOPA	Concerns around airspace requirements & GA access	Considered in the development of the network options
Lufthansa LIDO	Minimal changes are unlikely to create technical issues for flight planners due to database storage	Considered in the development of the network options
BGA	Definition of DRA or FRA above a particular level (32,000?) would alleviate some of the BGA's concerns	This ACP is predominantly concerned with changes from 7,000ft (FL70) to FL245. See 1.3.6

Table 19 Stakeholder Feedback for Network Option 5

4.1.21 Based on this feedback, this concept is not progressed through to the comprehensive list for DPE. Stakeholders have recognised the limitations of this concept, and the feedback from the majority indicates this is not a suitable option for the LTMA.

4.2 Design Principle Evaluation (DPE)

4.2.1 Table 20 shows the DPE assessment criteria. SMEs, in this case air traffic control experts and airspace change experts, list topics associated with each DP and qualitatively test how each option would react to those topics, describing how a red/amber/green outcome is reached.

DP	Priority	Description	SME subjective assessment topics, include but not limited to	Red	Amber	Green
0	A AMS	**Safety** Safety is always the highest priority (Note: Red could not be solved by mitigation, amber may be able to be solved by mitigation).	Human performance (ATCO control-ability) Human performance (pilot fly-ability) IFP (fly-ability) Surrounding airspace users (inside/outside of CAS) Impact if ATM tools fail	Unacceptable level of safety risk	Diminished - Issue(s) identified could result in an elevated level of safety risk when compared to today's operation	Enhanced - improvement over today's level of safety. Maintained - safety risk could be maintained within acceptable levels of today's operation
1	B AMS	**Operational** The airspace will enable increased operational resilience	Network Weather avoidance Disruption in neighbouring ANSPs	Reduced resilience and capacity during disruption	Similar resilience and capacity during disruption	Increased resilience and capacity during disruption
			Airport Holding levels Delay absorption between hold and 7,000ft	Reduction in delay absorption	Delay absorption similar to today	Improve delay absorption
			Airport Time to restart after runway closure Number of aircraft off the hold	Reduction in disruption recovery	Disruption recovery similar to today	Improve disruption recovery
2	B	**Economic** Optimise network fuel performance	Track mileage Economic performance Aircraft height Method of delay absorption	Fuel performance worsened	Fuel performance similar to today	Fuel performance improved
3	B AMS	**Environmental** Optimise CO_2 emissions per flight	Track mileage GHG performance Aircraft height Method of delay absorption	CO_2 emissions worsened	CO_2 emissions similar to today	CO_2 emissions improved
4	C	**Environmental** Minimising of noise impacts due to LAMP influence will take place in accordance with local needs	Overall environmental impact Environmental impact below 7,000ft Impact on tranquillity (or visual intrusion)	LAMP influence not aligned with local ACP sponsors' needs	Extent of alignment not yet known	LAMP influence fully aligned with local ACP sponsors' needs

DP	Priority	Description	SME subjective assessment topics, include but not limited to	Red	Amber	Green
5	C	Technical The volume of controlled airspace required for LAMP should be the minimum necessary to deliver an efficient airspace design, taking into account the needs of the UK airspace users	Lateral footprint of CAS Vertical footprint of CAS Proportional to airport traffic levels	Airspace required not the minimum necessary to deliver an efficient design	Extent of airspace required not yet known	Airspace required the minimum necessary to deliver an efficient design
6	C AMS	Technical The impacts on GA and other civilian airspace users due to LAMP will be minimised	Change to boundaries of CAS Changes to CAS classification Safety based impacts	Excessive negative impacts	Negative impacts minimised but requires changes to other airspace users' activities	Negative impacts minimised, no impact, or positive impacts to other airspace users' current activities
7	C AMS	Technical The impacts on MoD users due to LAMP will be minimised	Overall amount of danger area available Amount of time for danger area available Flexible use airspace provision Change to access between danger areas Safety based impacts Radar corridor access	Negative impacts not minimised or would require excessive changes to current MoD operations	Negative impacts minimised but requires changes to current MoD operations Or Extent of impact not yet known	Negative impacts minimised or no negative impact on current MoD operations
8	B AMS	Operational Systemisation will deliver the optimal capacity and efficiency benefits (Note: This is about airspace capacity, not ground infrastructure capacity which could be the limiting factor to overall airport capacity).	Traffic throughput Sectorisation Effect on overall network capacity Effect on airports' arrival flow	Design option unable to support the forecast traffic loading for the airport and the network	Design option supports the forecast traffic loading for the airport or the network	Design option supports the forecast traffic loading beyond the reference period for both the airport and the network
			Overall ATCO workload Levels of tactical intervention (radio transmissions per flight) No increase to operations requirements Balancing out of hot spots	Design option increases ATCO workload	ATCO workload similar to today	Design option decreases ATCO workload

DP	Priority	Description	SME subjective assessment topics, include but not limited to	Red	Amber	Green
9	B AMS	Technical The main route network linking airport procedures with the En Route phase of flight will be spaced to yield maximum safety and efficiency benefits by using an appropriate standard of PBN (Note: The main route network is considered as FL70 - FL245. Approach structures are not considered as 'the main route network').	Airspace requirement vs. RNAV rating Require aircraft equipage standards	PBN standard applied to route spacing would decrease efficiency and safety	PBN standard applied to route spacing would limit efficiency and safety benefits	PBN standard applied to route spacing is likely to maximise efficiency and safety benefits
10	A	Policy Must accord with the CAA's published Airspace Modernisation Strategy (CAP1711) and any current or future plans associated with it.	AMS "Ends" Strategic Objectives Safety (DP0) Integration of diverse users (DP6 and DP7) Simplification (DP1, DP8 and DP9) Environmental sustainability (DP3)	No or limited alignment with the AMS	Partial alignment with the AMS	Aligned with the AMS

Table 20 Design Principle Evaluation Assessment Criteria

4.2.2 Table 21 shows the AMS assessment criteria which are used to determine the overall RAG status for DP10.

DP10 outcome	Criteria for DP0, DP1, DP3, DP6, DP7, DP8 and DP9
Red	DP0 (Safety) is red OR 2 other DPs are red
Amber	All other colour combinations not covered by Red or Green
Green	2 DPs are green and 0 are red OR 3 DPs are green and 1 is red

Table 21 - AMS Assessment Criteria

4.2.3 The criteria in Table 22 describe how each option's overall combination of reds/ambers/greens lead to the option progressing to the next step or to rejection and discounting from further development.

DP Priority	Criteria for Rejection Status
A	1 red OR 1 amber
B	2 reds
C	2 reds

Table 22 - Accept / Reject Criteria

4.2.4 Three options were progressed (and 'Do Nothing') to the comprehensive list for evaluation against the design principles (Table 23).

DP	Priority	Option 0: Do Nothing	Option 1: Highly Systemised	Option 2: Hybrid Systemised
RESULT		REJECT	REJECT	ACCEPT
DP0 Safety	A AMS	Maintained: Similar operation to today	Enhanced: Reduced controller tactical intervention required, reducing potential for human error	Enhanced: Reduced controller tactical intervention required, reducing potential for human error
DP1 Operational (Resilience)	B AMS	Today's operation, no change from baseline	Lack of readily available alternative routes (recognised by the FDS system) and consequent extreme increases in workload	Management of disruption and consequent workload sustainable. Net similar to today
DP2 Economic (Fuel)	B	Today's operation, no change from baseline	Increased track miles and suboptimal profiles required to maintain separation. Reduced fuel performance	PBN routes, where appropriate, would enable optimised flight profiles which would yield improved fuel performance
DP3 Environmental (CO_2)	B AMS	Today's operation, no change from baseline	Increased track miles and suboptimal profiles required to maintain separation. CO_2 emissions per flight worsened	PBN routes, where appropriate, would enable optimised flight profiles which would yield improved CO_2 emissions
DP4 Environmental (Noise)	C	Today's operation, no change from baseline	Impact on routes (and noise distribution) below 7,000ft not known at this point	Impact on routes (and noise distribution) below 7,000ft not known at this point
DP5 Technical (CAS)	C	Today's operation, no change from baseline	Extent of airspace required not yet known, will be identified in Stage 3	Extent of airspace required not yet known, will be identified in Stage 3
DP6 Technical (Other Users)	C AMS	Today's operation, no change from baseline	Changes to other airspace users' activities are expected but details not yet known	Changes to other airspace users' activities are expected but details not yet known
DP7 Technical (MoD)	C AMS	Operation is known not to impact MoD currently, therefore no change in impact	Is likely to have an excessive negative impact on MoD operations due to requirement for all routes to be separated by design	Impacts minimised but may requNegative ire changes to current MoD operations
DP8 Operational (Capacity)	B AMS	Design option unable to support the forecast traffic loading for the airports and the network	Aligns with network traffic flows and concept can support the airports' required arrival loading	Aligns with network traffic flows and concept can support the airports' required arrival loading
DP8 Operational (Efficiency)	B AMS	Today's operation, no change in ATCO workload anticipated	Design option will reduce tactical intervention, therefore reducing ATCO workload	Design option will reduce tactical intervention, therefore reducing ATCO workload
DP9 Technical (Route Spacing)	B AMS	Does not fully utilise the performance capabilities of modern aircraft	Structure will be designed, in collaboration with the airports, to the highest appropriate PBN standard enabling efficient spacing between routes	Structure will be designed, in collaboration with the airports, to the highest appropriate PBN standard enabling efficient spacing between routes
DP10 Policy (AMS)	A	Green: DP0, DP7 Amber: DP1, DP3, DP6, DP8 Red: DP8, DP9	Green: DP0, DP8, DP8, DP9 Amber: DP6 Red: DP1, DP3, DP7	Green: DP0, DP3, DP8, DP8, DP9 Amber: DP1, DP6, DP7 Red: None

DP	Priority	Option 4: Direct Route Airspace
RESULT		REJECT
DP0 Safety	A AMS	Unacceptable: In a TMA, and with the forecast traffic loading, the level of complexity would lead to an unacceptable safety risk
DP1 Operational (Resilience)	B AMS	Management of disruption and consequent workload sustainable. Net similar to today
DP2 Economic (Fuel)	B	Improved fuel performance due to flying prescribed direct routes between designated points
DP3 Environmental (CO_2)	B AMS	Improved CO_2 emissions per flight due to flying prescribed direct routes between designated points
DP4 Environmental (Noise)	C	Impact on routes (and noise distribution) below 7,000ft not known at this point
DP5 Technical (CAS)	C	Extent of airspace required not yet known, will be identified in Stage 3
DP6 Technical (Other Users)	C AMS	Changes to other airspace users' activities are expected but details not yet known
DP7 Technical (MoD)	C AMS	Negative impacts minimised but may require changes to current MoD operations
DP8 Operational (Capacity)	B AMS	Does not support the network forecast due to no PBN standard associated with the routes and the complexity of the LTMA. There is uncertainty how much support this option would provide airports' forecast traffic loading. However, assuming a best-case scenario where it *may* support, the outcome would be amber.
DP8 Operational (Efficiency)	B AMS	Airspace design likely to create additional conflictions, which would increase ATCO workload
DP9 Technical (Route Spacing)	B AMS	No PBN standard could be applied as there would be no routes to space. This would decrease efficiency and safety
DP10 Policy (AMS)	A	Green: DP3 Amber: DP1, DP6, DP7, DP8 Red: DP0, DP8, DP9

Table 23 Network Design Principle Evaluation

4.2.5 As a result of the DPE, Option 0 (Do Nothing), Option 1 (Highly Systemised) and Option 4 (Direct Route Airspace) did not progress. Option 2 (Hybrid Systemised) has progressed to the Initial Options Appraisal step.

4.3 Initial Options Appraisal (IOA)

Table 24 shows the assessment criteria used to complete the initial appraisal of each shortlisted option.

Group	Impact
Communities	Noise impact on health and quality of life
A qualitative assessment of changes to noise impacts compared with the 'Do Nothing' baseline. A qualitative assessment of changes to tranquillity impacts compared with the 'Do Nothing' baseline.	
Communities	Air Quality
A qualitative assessment of changes to local air quality compared with the 'Do Nothing' baseline.	
Wider Society	Greenhouse Gas Impacts
A qualitative assessment of changes to greenhouse gas impacts compared with the 'Do Nothing' baseline.	
Wider Society	Capacity / Resilience
A qualitative assessment of changes to airspace capacity and resilience compared with the 'Do Nothing' baseline.	
General Aviation (GA)	Access
A qualitative assessment of changes to GA access compared with the 'Do Nothing' baseline.	
GA/Commercial Airlines	Economic Impact from Increased Effective Capacity
A qualitative assessment of changes to GA and commercial airline economic impacts from increased effective capacity compared with the 'Do Nothing' baseline.	
GA/Commercial Airlines	Fuel Burn
A qualitative assessment of changes to GA and commercial airline fuel burn impacts compared with the 'Do Nothing' baseline.	
Commercial Airlines	Training Costs
A qualitative assessment of changes to commercial airline training costs compared with the 'Do Nothing' baseline.	
Commercial Airlines	Other Costs
A qualitative assessment of changes to other relevant commercial airline costs compared with the 'Do Nothing' baseline.	
Airport / ANSP	Infrastructure Costs
A qualitative assessment of changes to airport and ANSP infrastructure costs compared with the 'Do Nothing' baseline.	
Airport / ANSP	Operational Costs
A qualitative assessment of changes to airport and ANSP operational costs compared with the 'Do Nothing' baseline.	
Airport / ANSP	Deployment Costs
A qualitative assessment of changes to airport and ANSP deployment costs compared with the 'Do Nothing' baseline.	
All	Performance against the vision and parameters/strategic objectives of the AMS
A qualitative assessment of how the design option performs, considering the AMS objectives of improved capacity, reduced CO_2, minimal impact on other users, maintaining or enhancing safety, and facilitation of defence and security objectives, compared with the 'Do Nothing' baseline.	

Table 24 Initial Options Appraisal Assessment Criteria

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Option 0 Do Nothing	Qualitative Initial Impacts Assessment	REJECTED
Group	Impact	
Communities	Noise impact on health and quality of life	
CAP1616 instructs sponsors to consider noise and tranquillity impacts where the proposal has the potential to change overflight of inhabited areas, AONBs and NPs below 7,000ft. In this network-level proposal, changes would not occur below 7,000ft therefore these impacts are not considered.		
Communities	Air Quality	
ANG (2017) states "emissions from aircraft above 1,000ft are unlikely to have a significant impact on local air quality". No change in airspace design – no changes to impacts.		
Wider Society	Greenhouse Gas Impacts	
In the short term, there would be no change in impact. In the long term, failure to modernise the airspace would have a negative impact on GHG emissions due to increased likelihood of delays/holding in an unchanged design as traffic is forecast to increase.		
Wider Society	Capacity / Resilience	
In the short term, there would be no change in impact. In the long term, failure to modernise the airspace would have a negative impact on capacity and resilience due to increased likelihood of delays/holding in an unchanged design as traffic is forecast to increase.		
General Aviation (GA)	Access	
In the short term, there would be no change in impact. In the long term, failure to modernise the airspace would lead to increased likelihood of commercial aircraft delays and holding in an unchanged design as traffic is forecast to increase. This may lead to negative impacts on GA access due to the busier airspace, however as GA access is currently relatively infrequent at network levels, this may not be a major impact.		
GA/Commercial Airlines	Economic Impact from Increased Effective Capacity	
In the short term, there would be no change in impact. In the long term, failure to modernise the airspace would have a negative impact on capacity due to increased likelihood of delays/holding in an unchanged design as traffic is forecast to increase. This would lead to a negative economic impact.		
GA/Commercial Airlines	Fuel Burn	
In the short term, there would be no change in impact. In the long term, failure to modernise the airspace would have a negative impact on fuel burn due to increased likelihood of delays/holding in an unchanged design as traffic is forecast to increase.		
Commercial Airlines	Training Costs	
Flight procedures change worldwide with each AIRAC cycle and airlines would update their procedures accordingly, training if required. If this baseline system was retained, the same flight procedures would be used, and training cost impacts would not change.		
Commercial Airlines	Other Costs	
No change in airspace design – no changes to other commercial operator costs.		
Airport / ANSP	Infrastructure Costs	
No change in airspace design – no changes to infrastructure costs. If this baseline system was retained, the same infrastructure would continue to be used in the same way, with no additional costs.		
Airport / ANSP	Operational Costs	
No change in airspace design – no changes to infrastructure costs. If this baseline system was retained, the same infrastructure would continue to be used in the same way, with no additional operational costs.		
Airport / ANSP	Deployment Costs	
If this baseline system was retained, there would be no deployment, hence no associated costs.		
AMS	Performance against the vision and parameters/strategic objectives of the AMS	
• Safety: maintained • Simplification: worsens delay absorption, disruption recovery, airport capacity, network capacity and ATCO workload. Does not utilise aircraft performance capabilities • Integration of diverse users: continues to integrate defence and security and GA • Environmental sustainability: worsens CO_2 emissions		
Qualitative Safety Assessment		
A high-level safety appraisal for this proposed option indicates that if the baseline system was retained, the existing level of safety performance undertaken within the current operation would be at least maintained. However, if there was no change to the current operation the potential increase in traffic as forecast would increase controller workload and traffic complexity within the LTMA leading to potential safety issues in the future. In order to mitigate any reduction in safety margins it is likely that increased flow management measures would be required, resulting in additional delay.		
Conclusion from IOA		
This option was rejected during the DPE stage. It has been included for comparison purposes only.		

Table 25 Network Option 0 Do Nothing – Initial Options Appraisal

Option 2 Hybrid Systemised Qualitative Initial Impacts Assessment	PROGRESSED
Group	**Impact**
Communities	Noise impact on health and quality of life
ANG (2017) states "at or above 7,000ft…minimising of noise is no longer a priority". CAP1616 limits tranquillity impacts to overflights of AONBs and NPs below 7,000ft. Changes would occur at or above 7,000ft, thus in accordance with ANG (2017) there would be no change in noise or tranquillity impacts.	
Communities	Air Quality
ANG (2017) states "emissions from aircraft above 1,000ft are unlikely to have a significant impact on local air quality". Changes would occur at or above 7,000ft, thus in accordance with ANG (2017) there would be no change in local air quality impacts.	
Wider Society	Greenhouse Gas Impacts
The hybrid system would enable the flexibility to access optimised flight profiles. Also, as traffic levels increase, delays/holding would be less than under the baseline. This option would yield a GHG improvement over the baseline.	
Wider Society	Capacity / Resilience
The hybrid system would enable the flexibility to access routes separated by design, leading to increased capacity and resilience to disruption. Also, as traffic levels increase, this capacity improvement would reduce the frequency of delays compared with the baseline. This option would therefore yield a capacity and resilience improvement over the baseline.	
General Aviation (GA)	Access
The baseline would increase the likelihood of commercial aircraft delays and holding in an unchanged design as traffic levels increase. This may lead to negative impacts on GA access due to the busier airspace. Conversely, the hybrid system would improve capacity, leading to reduced delays, reducing the likelihood of negative GA access impacts. However, the extent and classification of CAS required for this option is not yet determined. If less CAS is required, this would further improve GA access. If more CAS is required, this may negatively impact GA access, offsetting the positive access impacts due to reduced delays for commercial traffic.	
GA/Commercial Airlines	Economic Impact from Increased Effective Capacity
The hybrid system would enable the flexibility to access routes separated by design, leading to increased capacity over the baseline. Enabling more flights to operate within the network is expected to provide an economic benefit.	
GA/Commercial Airlines	Fuel Burn
The hybrid system would enable the flexibility to access optimised flight profiles. Also, as traffic levels increase, delays would be less than under the baseline. This option would yield a fuel burn improvement compared with the baseline.	
Commercial Airlines	Training Costs
Flight procedures change worldwide with each AIRAC cycle and airlines would update their procedures accordingly, training if required. This option is not anticipated to impose additional training cost impacts for airlines.	
Commercial Airlines	Other Costs
No other airline costs are foreseen.	
Airport / ANSP	Infrastructure Costs
This design option is not expected to change airport or ANSP infrastructure impacts, beyond the initial deployment phase which will require some systems engineering amendments.	
Airport / ANSP	Operational Costs
This design option is not expected to change airport or ANSP operational cost impacts.	
Airport / ANSP	Deployment Costs
At this stage it is disproportionate to attempt to quantify deployment costs per design option. However, a large LTMA system change would involve training a large number of controllers and assistants via the use of various air traffic simulators (including sim prep, management, and staffing), with additional system engineering costs.	
AMS	Performance against the vision and parameters/strategic objectives of the AMS
• Safety: enhances safety • Simplification: would improve resilience, disruption recovery, network and airport capacity, and ATCO workload. Will utilise aircraft performance capabilities • Integration of diverse users: continues to integrate defence and security and GA, subject to constraints of the design • Environmental sustainability: would yield a CO_2 emissions improvement	
Qualitative Safety Assessment	
A high-level safety assessment for this proposed option indicates that it would provide routes separated by design, leading to reduced controller tactical intervention and the potential for human error. It would also be more resilient to disruption. As traffic demand increases, more traffic could be handled safely before capacity begins to be constrained. This option would therefore enhance safety assurance over the baseline.	
Conclusion from IOA	
Compared to the baseline, Option 2 Hybrid Systemised offers better opportunities for improved safety, capacity, fuel, CO_2 and aligns with the AMS. This option is progressed to Stage 3 for further development.	

Table 26 Network Option 2 Hybrid Systemised – Initial Options Appraisal

4.4 Conclusion for the Network

4.4.1 This section has demonstrated how NERL have developed five initial option concepts for the network. We engaged with stakeholders and reviewed stakeholder feedback on the feasibility and viability of these options. This reduced the options to three, which were evaluated against the Design Principles. Only one option was progressed past this step.

4.4.2 The baseline ('Do Nothing' Option 0) is not viable. The hybrid systemised Option 2 is therefore the only option progressed to Stage 3 for further development. It is our preferred network option by default.

5. Design Option Development: Airport Connectivity Options

5.1.1 As described in Section 2.2, there were two key aspects to determine for each airport: the possible types of arrival structure (delay absorption mechanism) which could be viable, and the geographic feasibility. Five arrival structure types were identified as being viable options for potential airspace designs across the LTMA airports (see Figure 8). A design envelope and viability matrix were developed for each airport, described in the airport modules.

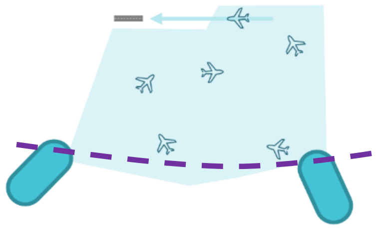
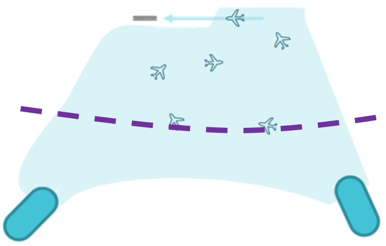
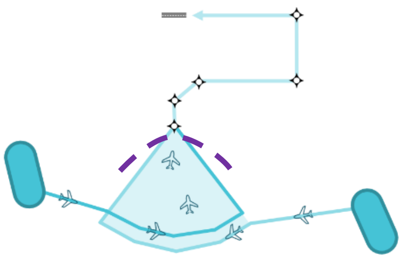
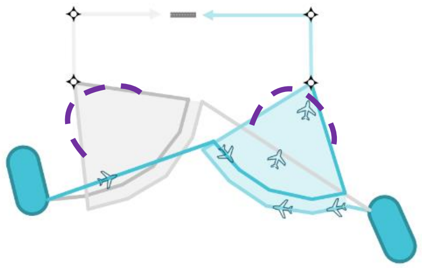
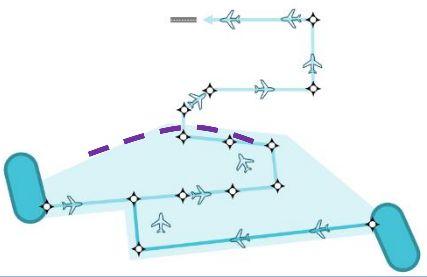
Structure	Diagram	Description
Optimised[15] Holds Illustration of network/airport boundary (indicative c.7,000ft)		A holding pattern is used to delay aircraft from landing, in a vertically separated stack. ATC control entry to, and exit from, the stack; and aircraft are vectored to the runway or may use a transition. Linked with either a traditional Radar Manoeuvring Area (RMA) or Transitions. This design is for holds within c.30nm of the airport.
Holds Further Out Illustration of network/airport boundary (indicative c.7,000ft)		As above but would typically be higher. This design is for holds c.30nm-60nm from the airport.
Point Merge Illustration of network/airport boundary (indicative c.7,000ft)		Point Merge (PM) is a systemised method for sequencing arrival flows, allowing controllers to sequence and merge arrivals without vectoring, whilst enabling continuous descent operations and maintaining runway throughput. This design has a fixed location regarding the merge legs and merge point.
Switch Merge Illustration of network/airport boundary (indicative c.7,000ft)		SM is a concept not currently in UK operation, whereby two separate PM structures exist within a given airspace volume to serve different runway directions for the same airport. The merge legs and merge point (the tip of each triangle) is angled to favour the runway in use, but only one of the merge structures is in operation at any time; they are 'switched' when the runway direction changes. The holds do not change.
Trombone Illustration of network/airport boundary (indicative c.7,000ft)		A 'snake-like' PBN transition which can be closed (fixed) which aircraft must fly; or open, whereby tactical flexibility is retained with defined short cuts.

Figure 8 Arrival structure concepts (at and above 7,000ft)

15 See paragraph 2.2.10 on page 12 for explanation of 'Optimised'

5.1.2 Stakeholders provided some feedback relevant to all arrival structure concepts, shown in Table 27. We used this feedback to inform the development and evaluation of the structures for individual airports. Airport specific feedback is included within their relevant airport module.

Stakeholder	Summary of Feedback ('You said')	Response ('We did')
BGA / Airspace4All	Any network supporting structure should be proportionate to the level of traffic.	Feedback was used to inform the evaluation of DP5 & DP6 for each airport.
Thales Avionics / Delta/ Boeing / Stansted	Systemised arrival structures could impact environmental benefits and reduce pilot and ATCO workload.	Feedback was used to inform the evaluation of DP2, DP3, DP4 & DP8 for each airport.
Airspace4All / Delta	Holds represent a failure to implement modern air traffic management; the scale of proposed holds should be reviewed.	Holds will be required to ensure there is a safe and resilient design, even if they are not routinely used. Hold requirements will be assessed and developed through Stage 3.
Stansted	The concept of optimised Inner Holds would offer respite.	Feedback was used to inform the evaluation of DP4 for each airport.
BGA	The use of airspace over the sea for arrival structures when appropriate is good.	We used this feedback to inform our evaluation of DP5 and DP6 for each airport.

Table 27 General stakeholder feedback on arrival concepts

5.1.3 The airport modules are available on the CAA airspace change portal, along with other supporting documentation.

6. Conclusion and Next Steps

6.1.1 The impacted airspace was split into 13 modules – one for the network (within this document) and one for each FASI airport.

6.1.2 NERL has engaged with our stakeholder audience, including ACOG and the change sponsors of interdependent ACPs, as part of the Masterplan programme. The engagement informed the development of our comprehensive list of options for each module, to the extent possible at this early stage.

6.1.3 The list addressed our Statement of Need and aligned with our Design Principles. We undertook a Design Principle Evaluation and subsequent Initial Options Appraisal, including either 'Do Nothing' or 'Do Minimum' options where relevant to the module.

6.1.4 We have identified all viable options, noting that the Masterplan is a high-level coordinated implementation plan of a series of individual airspace design changes, that need to be developed in coordination to achieve the range of benefits that modernisation can deliver.

6.1.5 We also state that at this stage we have no reason to believe the indicative design options would not comply with the required technical criteria, once fully refined.

6.1.6 These long lists of concepts have been illustrated within this documentation and developed through continued stakeholder feedback and engagement, alongside continued SME development work.

Module	Initial Long List	Comprehensive List	Progress to IOA	Progress to Stage 3
NERL LTMA Network	5	3	1	1
Biggin Hill	15	8	7	7
Bournemouth	11	11	4	4
Farnborough	11	4	2	2
Gatwick	15	11	7	7
Heathrow	36	17	9	9
London City	13	6	5	5
Luton	14	6	3	3
Manston	9	2	2	2
Northolt	34	17	9	9
Southampton	15	15	5	5
Southend	15	8	4	4
Stansted	17	7	5	5
TOTAL	210	115	63	63

Table 28 Count of Concept Design Options for each module through option development stages

6.1.7 Table 28 provides a summary of concept design options for each module, showing how the number of design options has changed through the design development stages. Further detail is provided in each module on the engagement feedback, design development and design principle evaluation.

6.1.8 Table 29 overleaf provides a summary list of the names of the options progressing to Stage 3 for further development.

Module (count)	Option(s) Progressed to Stage 3 for further development
NERL LTMA Network (1 option)	Hybrid Systemised Network (Option 2)
Biggin Hill (7 options)	Inner Holds – Northeast Inner Holds – East Inner Holds – Southeast Inner Holds – Southwest (Shared) Inner Holds – West (Shared) Point Merge – Northeast (Maybe shared) Point Merge – East (Do Minimum)
Bournemouth (4 options)	Inner Holds – Northeast (Maybe shared) Inner Holds – East (Do Minimum) (Maybe shared) Inner Holds – Southeast (Maybe shared) Inner Holds – South (Maybe shared)
Farnborough (2 options)	Inner Holds – South (Do Minimum) Inner Holds – Northwest
Gatwick (7 options)	Inner Holds – Southeast (Do Minimum) Inner Holds – South (Do Minimum) (Maybe shared) Inner Holds – Southwest Point Merge – Southeast Point Merge – South Switch Merge – Southeast Switch Merge – South
Heathrow (9 options)	Inner Holds – North (Do Minimum) (Maybe shared) Inner Holds – Northeast (Do Minimum) (Maybe shared) Inner Holds – East (Maybe shared) Inner Holds – Southeast (Do Minimum) (Maybe shared) Inner Holds – South (Do Minimum) (Maybe shared) Inner Holds – Southwest (Maybe shared) Inner Holds – Northwest (Maybe shared) Point Merge – North (Maybe shared) Point Merge – South (Maybe shared)
London City (5 options)	Inner Holds – Northeast Inner Holds – East Inner Holds – Southeast Point Merge – Northeast (Maybe shared) Point Merge – East (Do Minimum) (Maybe shared)
Luton (3 options)	Inner Holds – North (Do Minimum) Inner Holds – Northeast Point Merge – Northeast
Manston (2 options)	Network Connectivity Provision – Do Nothing Network Connectivity Provision – Do Minimum
Northolt (9 options)	Inner Holds – North (Maybe shared) Inner Holds – Northeast (Maybe shared) Inner Holds – East (Do Minimum) (Maybe shared) Inner Holds – Southeast (Do Minimum) (Maybe shared) Inner Holds – South (Do Minimum) (Maybe shared) Inner Holds – Southwest (Maybe shared) Inner Holds – Northwest (Do Minimum) (Maybe shared) Point Merge – North (Shared) Point Merge – South (Shared)
Southampton (5 options)	Inner Holds – North (Maybe shared) Inner Holds – Southeast (Maybe shared) Inner Holds – South (Maybe shared) Inner Holds – Southwest (Maybe shared) Inner Holds – Overhead (Do Minimum) (Maybe shared)
Southend (4 options)	Network Connectivity Provision – Do Nothing Inner Holds – Northeast Inner Holds – East Inner Holds – Southeast
Stansted (5 options)	Inner Holds – North Inner Holds – Northeast (Do Minimum) Inner Holds – Northwest (Do Minimum) Point Merge – North Point Merge – Northeast

Table 29 List of options progressed, by module

6.1.9 One Network option progressed and is the preferred option by default. There is not yet enough detailed quantified data to make a statement on preferred option(s) for the airport arrival structures. Compromises and trade-offs may be necessary between airports taking part in the FASI regional airspace change. Appropriate quantitative assessments and trade-offs will be carried out as part of Stage 3 to allow preferred option(s) to be selected prior to consultation.

6.2 Next Steps

6.2.1 The AMS allows for design options discounted at Stage 2 to be reintroduced at Stage 3 if necessary, during the Masterplan integration process where multiple ACP sponsors are all at the same stage, and it will be possible for a wider holistic overview to be considered.

6.2.2 In Stage 3 a cost-benefit analysis will be performed, and a preferred option (or combined system of options) will be stated.

6.2.3 Appropriate quantitative assessments will be carried out as part of Stage 3, and these will be monetised where possible:

- Fuel/CO_2 modelling analysis using the most recent appropriate version of EUROCONTROL's Base of Aircraft Data (BADA) as the data source, which will be processed via a fast-time simulation application.
- Fuel costs will be based on European market IATA jet fuel costs, converted from USD to GBP, both taken on a 'snapshot' date.
- ATC capacity changes due to this proposal will be modelled.
- It may be disproportionate to quantify some items depending on the circumstance and assumptions needed; in these cases, we will describe how a qualitative assessment provides adequate explanation.

6.2.4 A date for the Stage 3 Gateway Assessment has not yet been set and will depend on the progression of individual deployments as described in paragraph 1.2.3 on page 4.

6.2.5 For the latest information on this proposal, please subscribe to email updates on the CAA's airspace change portal.

7. Annex A: Summary of Stakeholder Engagement

This section summarises the external stakeholder engagement activities conducted during Stage 2.

Copies of the engagement material will be available unredacted for the CAA so they can make sure our engagement was effective.

Date	Activity	Audience/s	Key messages
13/09/2021	NERL/EGLL technical engagement	NERL/LL/ACOG	General tech engagement
20/09/2021	NERL/EGLL FASI workshop	NERL/LL/ACOG	General initial workshop
23/09/2021	NERL/EGKB engagement meeting	NERL/KB/ACOG	General engagement
07/10/2021	NERL/EGLC Stage 2 Discussion	NERL/LC/ACOG	General engagement
20/10/2021	NERL/EGKK FASI airspace meeting	NERL/KK/ACOG	General engagement
17/11/2021	NERL/EGKK Early Deployment Opportunities	NERL/KK/ACOG	Meeting to discuss whether Gatwick would be interested in an early deployment (circa 2026) to deliver benefits
24/11/2021	NERL/EGLF Early Deployment Opportunities	NERL/LF	Meeting to discuss whether Farnborough would be interested in an early deployment (circa 2026) to deliver benefits
29/11/2021	NERL/EGHI Early Deployment Opportunities	NERL/HI	Meeting to discuss whether Southampton would be interested in an early deployment (circa 2026) to deliver benefits
29/11/2021	EGLC/NERL Design Workshop	NERL/LC/ACOG	Meeting to review London City long list of options
01/12/2021	Heathrow Arrival Concepts meeting	NERL/LL/ACOG	Meeting to discuss possible options for Heathrow arrival structures
02/12/2021	NERL/EGGW Early Deployment Opportunities	NERL/GW	Meeting to discuss whether Luton would be interested in an early deployment (circa 2026) to deliver benefits
02/12/2021	NERL/EGSS Early Deployment Opportunities	NERL/SS	Meeting to discuss whether Stansted would be interested in an early deployment (circa 2026) to deliver benefits
10/12/2021	EGLC/NERL Design Workshop	NERL/LC/ACOG	General design workshop
15/12/2021	Stansted Arrival Concepts Meeting	NERL/SS	Meeting to discuss possible options for Stansted arrival structures
17/12/2021	EGHI/NERL Design Workshop	NERL/HI/ACOG	Meeting to discuss early design options from Southampton for possible inclusion in an early deployment (circa 2026) to deliver benefits
17/12/2021	NERL/EGKK Early Deployment Concepts	NERL/KK/ACOG	Meeting to discuss NERL early design options for Gatwick for possible inclusion in an early deployment (circa 2026) to deliver benefits
12/01/2022	Northolt Workshop	NERL/WU/ACOG	Catch up meeting to discuss progress made so far by both Northolt and NERL
17/01/2022	NERL/EGHH Early Deployment Opportunities	NERL/EGHH	Meeting to discuss whether Bournemouth would be interested in an early deployment (circa 2026) to deliver benefits
27/01/2022	NERL/EGSS Early Deployment Opportunities	NERL/SS/ACOG	Follow up meeting to discuss early design options from Stansted for possible inclusion in an early deployment (circa 2026) to deliver benefits
09/02/2022	EGKB/NERL Design Workshop	NERL/KB/ACOG	NERL/Biggin/ACOG updates. V2/V3 development. Airport requirements. Constraints. Departures route design options.
09/02/2022	NERL/EGGW Early Deployment Opportunities	NERL/GW/ACOG	Meeting to discuss whether Luton would be interested in an early deployment (circa 2026) to deliver benefits. NERL impact assessment of Luton routes.
11/02/2022	NERL/EGLL Deployment Sequence Meeting	NERL/LL/ACOG	NERL/HAL Deployment Sequence and Network Concepts Discussion
14/02/2022	NERL/EGLC Deployment Sequence Meeting	NERL/LC/ACOG	NERL/EGLC Deployment Sequence and Network Concepts Discussion
15/02/2022	NERL/EGHI engagement meeting	NERL/HI/ACOG	NERL initial Stage 2 engagement with the airports, detailing work which has been done so far, NERL approach to S2, V2/V3, future workshops
16/02/2022	NERL/EGKK Deployment Sequence Meeting	NERL/KK/ACOG	NERL/GAL Deployment Sequence and Network Concepts Discussion
16/02/2022	NERL/EGKK engagement meeting	NERL/KK/ACOG	NERL initial Stage 2 engagement with the airports, detailing work which has been done so far, NERL approach to S2, V2/V3, future workshops
16/02/2022	NERL/EGWU engagement meeting	NERL/WU	NERL initial Stage 2 engagement with the airports, detailing work which has been done so far, NERL approach to S2, V2/V3, future workshops
17/02/2022	NERL/EGMC engagement meeting	NERL/MC/ACOG	NERL initial Stage 2 engagement with the airports, detailing work which has been done so far, NERL approach to S2, V2/V3, future workshops

Date	Activity	Audience/s	Key messages
17/02/2022	NERL/EGMH engagement meeting	NERL/MH	NERL initial Stage 2 engagement with the airports, detailing work which has been done so far, NERL approach to S2, V2/V3, future workshops
17/02/2022	NERL/EGGW engagement meeting	NERL/GW	NERL initial Stage 2 engagement with the airports, detailing work which has been done so far, NERL approach to S2, V2/V3, future workshops
17/02/2022	NERL/EGSS engagement meeting	NERL/SS	NERL initial Stage 2 engagement with the airports, detailing work which has been done so far, NERL approach to S2, V2/V3, future workshops
18/02/2022	NERL/EGLC engagement meeting	NERL/LC/ACOG	NERL initial Stage 2 engagement with the airports, detailing work which has been done so far, NERL approach to S2, V2/V3, future workshops
28/02/2022	NERL/EGHH engagement meeting	NERL/HH/ACOG	NERL initial Stage 2 engagement with the airports, detailing work which has been done so far, NERL approach to S2, V2/V3, future workshops
28/02/2022	NERL/EGLL engagement meeting	NERL/LL/ACOG	NERL initial Stage 2 engagement with the airports, detailing work which has been done so far, NERL approach to S2, V2/V3, future workshops
02/03/2022	EGKB/NERL Design Workshop	NERL/KB/ACOG	NERL/Biggin/ACOG updates. V2/V3 development. Airport requirements. Constraints. Departures route design options.
03/03/2022	NERL/EGHH Early Deployment Opportunities	NERL/HH/ACOG	Follow up meeting to discuss whether Bournemouth would be interested in an early deployment (circa 2026) to deliver benefits
07/03/2022	NERL/EGSS Design Workshop	NERL/SS	Initial design workshop. Arrival structures, departure swathes, constraints, requirements.
08/03/2022	NERL/EGGW Design Workshop	NERL/GW	Initial design workshop. Arrival structures, departure swathes, constraints, requirements.
11/03/2022	NERL/EGKK Early Deployment Opportunities	NERL/KK/ACOG	Follow up meeting to discuss early design options from Gatwick for possible inclusion in an early deployment (circa 2026) to deliver benefits
14/03/2022	NERL/Heathrow Workshop planning	NERL/LL/ACOG	Meeting to discuss the upcoming design workshop, preparation required, attendees, forum, output, etc..
15/03/2022	NERL/MH Engagement meeting	NERL/EGMH	Meeting to determine the aspirations and requirements of Manston and what the network will need to do.
16/03/2022	NERL/EGSS Design workshop	NERL/SS/ACOG	Follow up meeting to continue initial design work, specifically focusing on new/changing departure swathes
17/03/2022	NERL/EGMC Design workshop	NERL/MC	Initial design workshop. Arrival structures, departure swathes, constraints, requirements.
18/03/2022	NERL/EGSS Early Deployment Opportunities	NERL/SS/ACOG	Follow up meeting to discuss early design options from Stansted for possible inclusion in an early deployment (circa 2026) to deliver benefits
23/03/2022	NERL/EGHI Design workshop	NERL/HI	Initial design workshop. Arrival structures, departure swathes, constraints, requirements.
30/03/2022	NERL/EGKK Design Workshop	NERL/KK/ACOG	Initial design workshop. Arrival structures, departure swathes, constraints, requirements.
31/03/2022	NERL/EGLC Design Workshop	NERL/LC	Initial design workshop. Arrival structures, departure swathes, constraints, requirements.
07/04/2022	NERL/EGLL arrivals workshop	NERL/LL/ACOG	Initial design workshop. Arrival structures, departure swathes, constraints, requirements.
08/04/2022	EGMC S2 engagement	EGMC and stakeholders	Southend Stage 2 Design Principles engagement. NERL attendance as a stakeholder.
21/04/2022	NERL/EGWU Design Workshop	NERL/WU/ACOG	Initial design workshop. Arrival structures, departure swathes, constraints, requirements.
22/04/2022	NERL/EGHI Design Workshop	NERL/HI	Follow up design workshop. Arrival structures, departure swathes, constraints, requirements.
26/04/2022	NERL/EGKK Design Workshop	NERL/KK	Follow up design workshop. Specifically focussing on departure swathes, constraints, requirements.
27/04/2022	NERL/EGLL departures workshop	NERL/LL/ACOG	Follow up design workshop. Specifically focussing on departure swathes, constraints, requirements.
06/05/2022	NERL/MH Design Workshop	NERL/MH/ACOG	Design workshop. Specifically focussing on departure swathes, constraints, requirements.
12/05/2022	NERL/EGLL whole system workshop	NERL/LL/ACOG	Follow up design workshop. Specifically focussing on departure swathes, vis sim design options, whole system solutions
25/05/2022	NERL/EGLL/EGWU design workshop	NERL/LL/WU/ ACOG	Follow up design workshop. Specifically focussing on Northolt departure swathes, constraints, requirements. NERL presented the initial DA concepts.

Date	Activity	Audience/s	Key messages
06/06/2022	NERL/EGHH Design Workshop	NERL/HI/ACOG	Initial design workshop. Arrival structures, departure swathes, constraints, requirements.
07/06/2022	Lead Operator Carrier Panel	NERL/LOCP	Briefing to LOCP on NERL projects: OSEP, West, AMEP, DVOR, Borders and Central, Q&CM, LTMA Definition
08/06/2022	Lead Operator Carrier Panel	NERL/LOCP	Briefing to LOCP on NERL projects: West, LTMA Definition inc LTMA, ScTMA and MTMA
10/06/2022	GA Alliance briefing	NERL/GAA	Briefing to GA Alliance on NERL airspace projects inc: OSEP, LTMA, MTMA and ScTMA
05/07/2022	Gatwick Vis Sim visit	NERL/KK/CAA	Gatwick liaison visit to the vis sims for deployment A options
06/07/2022	NERL /Heathrow Vis Sim chat	NERL/LL	Discussion with LL on the concepts for the Vis Sims
07/07/2022	NERL /Stansted Vis Sim chat	NERL/SS	Discussion with SS on the concepts for the Vis Sims
08/07/2022	NERL /Luton Vis Sim chat	NERL/GW	Discussion with GW on the concepts for the Vis Sims
18/07/2022	NERL/Gatwick system options discussion	NERL/KK	Discussions on the Gatwick system options
27/07/2022	NERL/Gatwick design workshop	NERL/KK	Design workshop with NERL and Gatwick. This looked at how Gatwick system options might work with the NERL high level options
10/08/2022	NERL/Gatwick design workshop (follow up)	NERL/KK	Update following the previous weeks workshop. NERL feedback on multi Switch Merge options.
06/09/2022	NERL/Farnborough design workshop	NERL/LF	LF attendees acting as stakeholders in NERL ACP only.
09/09/2022	Heathrow Vis Sim visit	NERL/LL	Heathrow liaison visit to the vis sims for deployment B options
12/09/2022	NERL/KK catch up meeting	NERL/KK	Progress update from NERL and Gatwick: Ongoing visualisation sims, Network design schedule, CAF, Gatwick S2 gateway extension
13/09/2022	FASI Sponsor collaborative workshop (BPK)	NERL/ACOG/SS/LL/WU/ LC/GW	Initial collaborative design workshop focussing specifically on the BPK area, solely in westerly ops. Options drawn up where each airport sponsor had 'primacy'. No consideration given to easterly ops or east/west combinations. Also discussed the CAF and planned further workshops.
14/09/2022	Airport Sponsor Engagement pre meet	NERL/MH	Sponsor preview of the NERL stage 2 engagement presentation to allow sponsors to understand slides pertaining to their airport, provide initial feedback and ask questions
14/09/2022	Airport Sponsor Engagement pre meet	NERL/SS	Sponsor preview of the NERL stage 2 engagement presentation to allow sponsors to understand slides pertaining to their airport, provide initial feedback and ask questions
14/09/2022	Airport Sponsor Engagement pre meet	NERL/HH	Sponsor preview of the NERL stage 2 engagement presentation to allow sponsors to understand slides pertaining to their airport, provide initial feedback and ask questions
14/09/2022	Airport Sponsor Engagement pre meet	NERL/MC	Sponsor preview of the NERL stage 2 engagement presentation to allow sponsors to understand slides pertaining to their airport, provide initial feedback and ask questions
15/09/2022	Airport Sponsor Engagement pre meet	NERL/WU	Sponsor preview of the NERL stage 2 engagement presentation to allow sponsors to understand slides pertaining to their airport, provide initial feedback and ask questions
15/09/2022	Airport Sponsor Engagement pre meet	NERL/LF	Sponsor preview of the NERL stage 2 engagement presentation to allow sponsors to understand slides pertaining to their airport, provide initial feedback and ask questions
15/09/2022	Airport Sponsor Engagement pre meet	NERL/KK	Sponsor preview of the NERL stage 2 engagement presentation to allow sponsors to understand slides pertaining to their airport, provide initial feedback and ask questions
15/09/2022	Airport Sponsor Engagement pre meet	NERL/HI	Sponsor preview of the NERL stage 2 engagement presentation to allow sponsors to understand slides pertaining to their airport, provide initial feedback and ask questions
15/09/2022	Airport Sponsor Engagement pre meet	NERL/KB	Sponsor preview of the NERL stage 2 engagement presentation to allow sponsors to understand slides pertaining to their airport, provide initial feedback and ask questions
16/09/2022	Airport Sponsor Engagement pre meet	NERL/LL	Sponsor preview of the NERL stage 2 engagement presentation to allow sponsors to understand slides pertaining to their airport, provide initial feedback and ask questions
16/09/2022	Airport Sponsor Engagement pre meet	NERL/LC	Sponsor preview of the NERL stage 2 engagement presentation to allow sponsors to understand slides pertaining to their airport, provide initial feedback and ask questions
16/09/2022	Airport Sponsor Engagement pre meet	NERL/GW	Sponsor preview of the NERL stage 2 engagement presentation to allow sponsors to understand slides pertaining to their airport, provide initial feedback and ask questions

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Date	Activity	Audience/s	Key messages
20/09/2022	Stansted Vis Sim visit	NERL/SS	Stansted liaison visit to the vis sims for deployment B options
22/09/2022	Formal Stage 2 Engagement Briefing	Airline Operators	NERL stage 2 engagement presentation to stakeholders including but limited to: What we are doing and why, design methodology, network options, arrival structure options and feedback.
23/09/2022	Formal Stage 2 Engagement Briefing	Open Session	NERL stage 2 engagement presentation to stakeholders including but limited to: What we are doing and why, design methodology, network options, arrival structure options and feedback.
26/09/2022	Luton Vis Sim visit	NERL/GW	Luton liaison visit to the vis sims for deployment B options
26/09/2022	Formal Stage 2 Engagement Briefing	GAA/BGA	NERL stage 2 engagement presentation to stakeholders including but limited to: What we are doing and why, design methodology, network options, arrival structure options and feedback.
27/09/2022	Formal Stage 2 Engagement Briefing	Open Session	NERL stage 2 engagement presentation to stakeholders including but limited to: What we are doing and why, design methodology, network options, arrival structure options and feedback.
28/09/2022	Formal Stage 2 Engagement Briefing	Adjacent ANSPs/FASI Sponsors	NERL stage 2 engagement presentation to stakeholders including but limited to: What we are doing and why, design methodology, network options, arrival structure options and feedback.
29/09/2022	Formal Stage 2 Engagement Briefing	Military	NERL stage 2 engagement presentation to stakeholders including but limited to: What we are doing and why, design methodology, network options, arrival structure options and feedback.
29/09/2022	Formal Stage 2 Engagement Briefing	FASI Airport sponsors	NERL stage 2 engagement presentation to stakeholders including but limited to: What we are doing and why, design methodology, network options, arrival structure options and feedback.
30/09/2022	Formal Stage 2 Engagement Briefing	Airline Operators	NERL stage 2 engagement presentation to stakeholders including but limited to: What we are doing and why, design methodology, network options, arrival structure options and feedback.
30/09/2022	Formal Stage 2 Engagement Briefing	Open Session	NERL stage 2 engagement presentation to stakeholders including but limited to: What we are doing and why, design methodology, network options, arrival structure options and feedback.
30/09/2022	Heathrow Vis Sim visit	NERL/LL	Heathrow liaison visit to the Swanwick viewing gallery and vis sims for deployment B options
13/10/2022	London City Vis Sim Visit	NERL/LC	London City liaison visit to the vis sims for deployment C options
18/10/2022	Biggin Hill Vis Sim visit	NERL/KB	Biggin Hill liaison visit to the vis sims for deployment C options
26/10/2022	Southend Vis Sim Visit	NERL/MC	Southend liaison visit to the vis sims for deployment C options
31/10/2022	NERL/KK catch up meeting	NERL/KK/ACOG	Progress update from NERL and Gatwick: Early Deployment, Network design schedule, CAF, Gatwick S2 gateway extension
04/11/2022	NERL/WU catch up meeting	NERL/WU	Airspace update, vis sim B concepts, vis sim B output, Northolt update
15/11/2022	NERL/British Skydiving initial engagement	NERL/British Skydiving	NERL initial Stage 2 engagement with British Skydiving, detailing work which has been done so far, NERL approach to S2, future workshops, work continuing into stage 3 and future engagement
15/11/2022	Channel Airspace Development Group meeting	NERL and Adjacent ANSP's	NERL Stage 2 engagement with adjacent ANSPs, detailing work which has been done so far, NERL approach to S2, future workshops, work continuing into stage 3 and future engagement
18/11/2022	NERL/GAA/BGA engagement meeting	NERL/GAA/BGA	NERL Stage 2 engagement with the GAA and BGA, detailing work which has been done so far, NERL approach to S2, future workshops, work continuing into stage 3 and future engagement. Asking the attendees what airspace is important to them and why.
24/11/2022	MUAC Engagement meeting	NERL/MUAC	NERL Stage 2 engagement with adjacent ANSPs, detailing work which has been done so far, NERL approach to S2, future workshops, work continuing into stage 3 and future engagement
07/12/2022	Lead Operator Carrier Panel	NERL/LOCP	Briefing to LOCP on NERL projects: OSEP, West, AMEP, DVOR, Borders and Central, Q&CM, LTMA Definition

Date	Activity	Audience/s	Key messages
08/12/2022	Lead Operator Carrier Panel	NERL/LOCP	Briefing to LOCP on NERL projects: OSEP, West, AMEP, DVOR, Borders and Central, Q&CM, LTMA Definition
19/01/2023	Gatwick FASI Safety Assessment for IOA	Stakeholders of GAL	Which of the proposed Gatwick system options should not be progressed due to potential safety concerns
25/01/2023	Gatwick FASI Stakeholder IOA Engagement	Stakeholders of GAL	Which of the proposed Gatwick system options will/will not be progressed to the IOA
01/02/2023	NATS and Business Aviation Forum	NERL/BizJet Forum members	Introduction to the FASI programme. What is happening. NERL stage 2 recap.
10/02/2023 – 17/02/2023	FASI Sponsors preview of arrival design options shortlist	LTMA FASI airports	Brief summary of engaged-upon options and shortlist options to progress to Stage 3
21/02/2023	NERL trilateral workshop	NERL/LL/WU	Discussion on shortlist options

Table 30 Summary of Stakeholder Engagement

8. Annex B: Stakeholder List

Grouped lists of stakeholders we contacted to encourage participation in our Stage 2 engagement activities, alphabetically by column.

Airlines and Aircraft Operators			
Aer Lingus	DHL	Jet2	Saudia
Air Canada	Eastern Airways	JetBlue	Singapore Airlines
Air France	easyJet	KLM	Swiss
Air Transat	Emirates	Logan Air	TAG Aviation
American Airlines	Etihad	Lufthansa	TAP Air Portugal
Aurigny Air Services	Eurowings	Malaysia Airlines	Titan
Austrian Airlines	FedEx	Middle East Airlines	TUI
Azerbaijan Airlines	FinnAir	NetJets	Turkish Airlines
Blue Islands	Fly Dubai	Norwegian Air	United Airlines
BA Cityflyer	Flybe[16]	Novair	UPS Europe
British Airways	Gama Aviation	Qantas	Virgin Atlantic
Cathay Pacific	Gulf Air	Qatar Airways	West Jet
Cityjet	Iberia	RyanAir	WizzAir
Delta Airways	Iceland Air	Scandinavian Airlines SAS	

FASI Airports			
Biggin Hill	Gatwick	Luton	Southend
Bournemouth	Heathrow	Manston	Stansted
Farnborough	London City	Northolt	Southampton

Other Airports			
Birmingham	Cardiff	Exeter	Liverpool
Blackpool	East Midlands	Leeds Bradford	Manchester
Bristol			

ANSPs (Air Navigation Service Providers)			
DSNA Brest	DSNA Reims	Irish Aviation Authority	Ports of Jersey
DSNA HQ	Eurocontrol Maastricht	LVNL Netherlands	Skeyes Belgium
DSNA Paris			

Airframe Manufacturers, Flight Management System Manufacturers, Coding Houses			
Airbus	Honeywell	NavBlue	Thales
Boeing	Jeppesen	Rockwell Collins	
General Electric	Lufthansa Systems	Sabre	

Military Representatives	
MoD Defence Airspace and Air Traffic Management (DAATM)	RAF 78 Squadron (Swanwick)

[16] Flybe was still trading at the time of engagement

NATMAC (National Air Traffic Management Advisory Committee)			
AEF Aviation Environment Federation	BALPA British Airline Pilots Association	BMFA British Model Flying Association	Honourable Company of Air Pilots
Airlines UK	BBAC British Balloon and Airship Club	British Skydiving	Iprosurv Professional Drone Pilots
Airspace4All	BBGA British Business & General Aviation Association	Drone Major Professional Drone Pilots	LAA Light Aircraft Association
AOA Airport Operators' Association	BGA British Gliding Association	GAA General Aviation Alliance	Low Fares Airlines representative
AOPA Aircraft Owners and Pilots Association	BHA British Helicopter Association	GATCO Guild of Air Traffic Control Officers	PPL/IR Europe representing light aircraft instrument pilots
ARPAS-UK Association of Remotely Piloted Aerial Systems	BHPA British Hang Gliding and Paragliding Association	HCGB Helicopter Club of Great Britain	UK Flight Safety Committee
BAE Systems	BMAA British Microlight Aircraft Association	Heavy Airlines	

Other Aviation Stakeholder Organisations			
Bristow Helicopters	BAR Board of Airline Representatives UK	Light Airlines representative	UK DfT Department for Transport
AIRE Airlines International Representation in Europe	Heathrow Airline Operators Committee	MAG Manchester Airports Group	
Airlines For America	IATA International Air Transport Association	UK Air Tanker	

9. Annex C: Summary of General Safety Assessment

9.1.1 This section provides a brief, qualitative overview of the impact of the holistic change on aviation safety.

9.2 Options Appraisal Safety Assessment – Baseline

9.2.1 The current operation uses a published route structure and airline operators flight plan to follow available ATS routes as published in the UK AIP or flight plannable Directs (DCTs) as published in the Route Availability Document.

9.2.2 Flights into and out of the airspace volume are managed via published waypoints between adjacent sectors. Transfer of traffic between these sectors is often conducted through the use of standing agreements and established coordination procedures as detailed in specific sections of the MATS pt. 2.

9.2.3 The published routes are historically predicated on ground-based navigation aids, based upon an outdated airspace design, and traffic needs to be tactically deconflicted by Air Traffic Controllers. This creates a high workload environment with a lack of overall predictability for airlines. In support to the need for change explained in Section 1.5, Safety by Design principles should be applied to design-out some of the current limitations and further improve safety while enhancing the overall airspace benefits.

9.2.4 In addition to following routes, some flights may be instructed to take a more direct path through the airspace. This is done in a tactical manner by Air Traffic Controllers based on their judgement that a different path can be followed safely.

9.2.5 Project activities so far have included a questionnaire directed at Swanwick (Area Control, Terminal Control and Approach) Air Traffic Controllers and workshops held with all twelve FASI airports. Feedback from these has enabled a range of concepts to be assessed through visualisation simulations based upon iterative development.

9.3 Options Appraisal Safety Assessment – Options Development

9.3.1 Key elements of the proposed change include systemised routes designed to improve traffic flow and increase capacity, as well as new arrival and departure route connectivity which may require additional controlled airspace.

9.3.2 A qualitative high-level safety appraisal indicates that nothing is presently foreseen, in any of the proposed and accepted options for the LTMA, that appears to have the potential to preclude maintenance of the existing level of safety performance undertaken within the current operation.

9.3.3 The completed Airspace Safety Review will inform a series of real-time development simulations currently scheduled for October 2023 onwards.

9.4 **Summary**

9.4.1 The initial findings from workshops at the time of this Safety Statement are described below. Due to the nature of airspace analysis, the individual elements of the designs have been assessed holistically.

9.4.2 Visualisation Simulations:
Based on feedback from the workshops held with all relevant stakeholders, feedback from the controller questionnaire and drawing on previous design work, concepts were created which contained a number of new design elements. These were presented to LTMA controllers, airfield sponsors and airline operators by means of visualisation simulations. These were held at Swanwick Centre in the SPACE research and development facility and used fictional traffic samples to represent the routes within the design concepts on a radar display and were used to show how aircraft would travel through the new airspace. It allowed the new design concepts to be understood and interactions between aircraft to be seen. It also facilitated discussion around sectorisation, coordination sequences and general opinions and ideas about the suitability of the designs and how they could be improved. A number of visualisation simulations were conducted during the period August - October 2022 which included extensive controller participation and stakeholder engagement. The output of these simulations will be used to create and refine the designs that will be taken to series of real-time development simulations scheduled for October 2023 onwards.

9.4.3 Airspace Safety Review:
The Airspace Safety Review (ASR) will take place within Stage 3 to await the maturing of the LTMA designs. Therefore, a reliable net safety benefit/disbenefit will not be fully realised until a complete safety assessment is conducted in Stage 3. At this stage, Safety do not foresee safety issues associated with any of the design elements.

9.5 **Future activities**

9.5.1 Subject to safety analysis, a safety strategy will be captured within the Safety Assurance Plan.

9.5.2 Further analysis and activities will be conducted on the proposed design options that will include:

- Hazard Identification and Analysis
- Real-Time Development Simulations

9.5.3 Work is ongoing to provide detailed quantitative safety assessments for subsequent CAP1616 stages.

9.5.4 At this time, there are no indications to suggest any of the current options would be unsafely implemented.

10. Annex D: Glossary

ACOG	Airspace Change Organising Group	ACOG's role is to coordinate the delivery of key aspects of the UK Government's Airspace Modernisation Strategy.
ACP	Airspace Change Proposal	An Airspace Change Proposal is a request from a 'change sponsor', usually an airport or a provider of air navigation services (including air traffic control), to change the notified airspace design.
ADWR	Airspace Development Workshop Records	Outputs from NERL led collaborative design workshops.
AIP	Aeronautical Information Publication	A publication issued by or with the authority of a state and containing aeronautical information of a lasting character essential to air navigation.
AMS	Airspace Modernisation Strategy	The strategy sets out the "ends", "ways" and "means" of modernising airspace.
ANG (2017)	Air Navigation Guidance (2017)	DfT guidance to the CAA and wider industry on airspace and noise management, the most current issue of which was published in 2017.
ANSP	Air Navigation Service Provider	An Air Navigation Service Provider is an organisation that provides the service of managing the aircraft in flight or on the manoeuvring area of an airfield and which is the legitimate holder of that responsibility.
AONB	Area of Outstanding Natural Beauty	An Area of Outstanding Natural Beauty is a designated exceptional landscape whose distinctive character and natural beauty are precious enough to be safeguarded in the national interest.
ATC	Air Traffic Control	Air Traffic Control is a service provided by ground-based air traffic controllers who direct aircraft on the ground and through a given section of controlled airspace and can provide advisory services to aircraft in non-controlled airspace.
ATCO	Air Traffic Control Officer	Air Traffic Control Officers are personnel responsible for the safe, orderly, and expeditious flow of air traffic in the global air traffic control system.
ATS	Air Traffic Services	An Air Traffic Service is a service which regulates and assists aircraft in real-time to ensure their safe operations.
BADA	Base of Aircraft Data	Analytical model on aircraft performance, developed and maintained by EUROCONTROL.
CAA	Civil Aviation Authority	The Civil Aviation Authority oversees and regulates all aspects of civil aviation in the United Kingdom.
CAP1385	CAA Performance-based Navigation (PBN): Enhanced Route Spacing Guidance	Guidelines for the spacing requirements of UK ATS routes.
CAP1616	CAA Airspace Change Process	The CAA's guidance on the regulatory process for changing the notified airspace design and planned and permanent redistribution of air traffic.

CAP1711	CAA Airspace Modernisation Strategy	See AMS.
CAS	Controlled Airspace	Generic term for the airspace in which an air traffic control service is provided as standard; note that there are different sub classifications of airspace that define the particular air traffic services available in defined classes of controlled airspace.
CCO	Continuous Climb Operations	Continuous Climb Operations is an aircraft operating technique facilitated by the airspace and procedures design and assisted by appropriate ATC procedures, allowing the execution of a flight profile optimised to the performance of aircraft, leading to significant economy of fuel and environmental benefits in terms of noise and emissions reduction.
CDO	Continuous Descent Operations	Continuous Descent Operations is an aircraft operating technique in which an arriving aircraft descends from an optimal position with minimum thrust and avoids level flight to the extent permitted by the safe operation of the aircraft and compliance with published procedures and ATC instructions.
CMATZ	Combined Military Aerodrome Traffic Zone	An airspace of defined dimensions established around more than one military aerodrome, in this case the United States Air Force in Europe operations at RAF Lakenheath and RAF Mildenhall.
CO_2	Carbon Dioxide	A greenhouse gas produced by burning aviation fuel.
DA	Danger Area	Airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times.
DAATM	Defence Airspace and Air Traffic Management	DAATM is the MoD focal point for all Defence Airspace policy, including airspace changes by all sponsors.
DCT	Direct	(Direct) Waypoint to waypoint routing, which does not use an airway. DCTs are published in the EUROCONTROL Route Availability Document.
DfT	Department for Transport	The Department for Transport is the UK Government department responsible for the English transport network and a limited number of transport matters in Scotland, Wales and Northern Ireland that have not been devolved.
DP	Design Principle	(CAP1616) The design principles encompass the safety, environmental and operational criteria and strategic policy objectives that the change sponsor aims for in developing the airspace change proposal.
DPE	Design Principle Evaluation	(CAP1616) The evaluation of design options against the established design principles, to progress or reject options according to alignment criteria.
FASI	Future Airspace Strategy Implementation	An airspace project modernising airspace in the UK.

FDS	Flight Data System	A computer system in an aircraft's flight deck that displays flight data to a pilot and contains a database of routes, waypoints and flight procedures
FIR	Flight Information Region	Flight Information Region (a defined region of airspace usually below FL255; the UK is divided into the London and Scottish FIRs).
FL	Flight Level	A flight level (FL) is an aircraft's vertical reference to a standard air pressure (1013hPa), expressed in hundreds of feet, e.g. FL100 is 10,000ft above the 1013hPa pressure datum.
FRA	Free Route Airspace	Free route airspace (FRA) is a specified airspace within which users may freely plan a route between a defined entry point and a defined exit point.
ft	feet	The standard measure for vertical distances used in air traffic control.
GA	General Aviation	All civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire. The most common type of GA activity is recreational flying by private light aircraft and gliders, but it can range from paragliders and parachutists to microlights, balloons and private corporate jet flights.
hPa	Hectopascal	The Hectopascal is the international unit for measuring atmospheric or barometric pressure.
IATA	International Air Transport Association	Trade association of the world's airlines.
IFP	Instrument Flight Procedure	Instrument Flight Procedure. An IFP is a defined sequence of manoeuvres an aircraft must make under certain conditions, with reference to instrumentation. They may only be designed by approved specialists. Examples include SIDs and STARs.
IOA	Initial Options Appraisal	(CAP1616) The Initial appraisal is based around a qualitative assessment. The Initial appraisal sets out how the change sponsor moves from its Statement of Need to a shortlist of options.
LAC	London Area Control	The air traffic control unit which manages en-route traffic in the London Flight Information Region. This includes en-route airspace over England and Wales up to the Scottish border.
LTC	London Terminal Control	The air traffic control unit which manages the traffic in the London TMA.
LTMA	London TMA	TMA surrounding the London group of airports.
Masterplan	Airspace Masterplan	ACOG's Masterplan identifies where airspace changes are needed to support the delivery of the Airspace Modernisation Strategy.
MoD	Ministry of Defence	The administration of the UK Government's military forces.
MTMA	Manchester TMA	TMA surrounding the Manchester group airports.

NATMAC	National Air Traffic Management Advisory Committee	A CAA-managed committee on which sit various groups of organisations representing users of UK Airspace.
NATS	UK ANSP	The organisation comprising the licensed & regulated NERL function (see below) and the commercial services element NATS Services Ltd (NSL) which is the contracted air navigation service provider at several UK airports and also provides other aviation consultancy services.
NERL	NATS En-route Ltd.	The UK's licenced air traffic service provider for the en route airspace network that connects our airports with each other, and with the airspace of neighbouring states. Part of NATS (see above).
NP	National Park	National Parks are protected landscapes which aims to conserve and enhance natural beauty, wildlife and cultural heritage whilst promoting understanding and enjoyment.
PBN	Performance Based Navigation	Performance Based Navigation is a generic term for modern standards for aircraft navigation capabilities including satellite navigation (as opposed to 'conventional' navigation standards).
PM	Point Merge	A systemised method for sequencing arrival flows, allowing controllers to sequence and merge arrivals without vectoring, whilst enabling continuous descent operations and maintaining runway throughput. This design has a fixed location regarding the merge legs and merge point.
RAF	Royal Air Force	The branch of the UK's military forces dedicated to aerial defence and combat
RMA	Radar Manoeuvring Area	An ATC operational area articulated as a volume of airspace, generally close into the airfield and is usually established solely for the purposes of segregating and protecting aircraft arriving and departing the same airfield.
SDR	Standard Departure Routes	Airport departure procedures that are less prescriptive than a SID
SID	Standard Instrument Departure	A Standard Instrument Departure is a published route with climb for aircraft to follow straight after take-off.
SM	Switch Merge	Two separate PM structures exist within a given airspace volume to serve different runway directions for the same airport. The merge legs and merge point (the tip of each triangle) is angled to favour the runway in use, but only one of the merge structures is in operation at any time; they are 'switched' when the runway direction changes. The holds do not change.
SME	Subject Matter Expert	A subject-matter expert is a person who is an authority in a particular area or topic.

SoN	Statement of Need	The Statement of Need sets out what issue or opportunity an airspace change seeks to address.
STAR	Standard Arrival Route	A Standard Arrival Route is a published route for arriving traffic. In today's system these bring aircraft from the route network to the holds (some distance from the airport at high levels), from where they follow ATC instructions (see Vector) rather than a published route. Under PBN it is possible to connect the STAR to the runway via a Transition.
TA	Transition Altitude	The Transition Altitude is the altitude at or below which the vertical position of an aircraft is controlled by reference to altitudes. Above the TA all aircraft are vertically referenced using Flight Levels.
TMA	Terminal Manoeuvring Area	A Terminal Manoeuvring Area is a Control Area normally established at the confluence of ATS Routes in the vicinity of one or more major aerodromes.
USAFE	United States Air Force in Europe	The division of the United States Air Force operating in Europe
Vector	also Vectoring	A standard controlling technique by which the ATCO instructs the pilot of an aircraft to turn to a specified compass heading and to climb or descend to a specified altitude or flight level. The controller manually dictates the precise path of an aircraft in order to achieve a desired outcome such as setting a landing sequence, ensuring separation, or shortening a route.

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