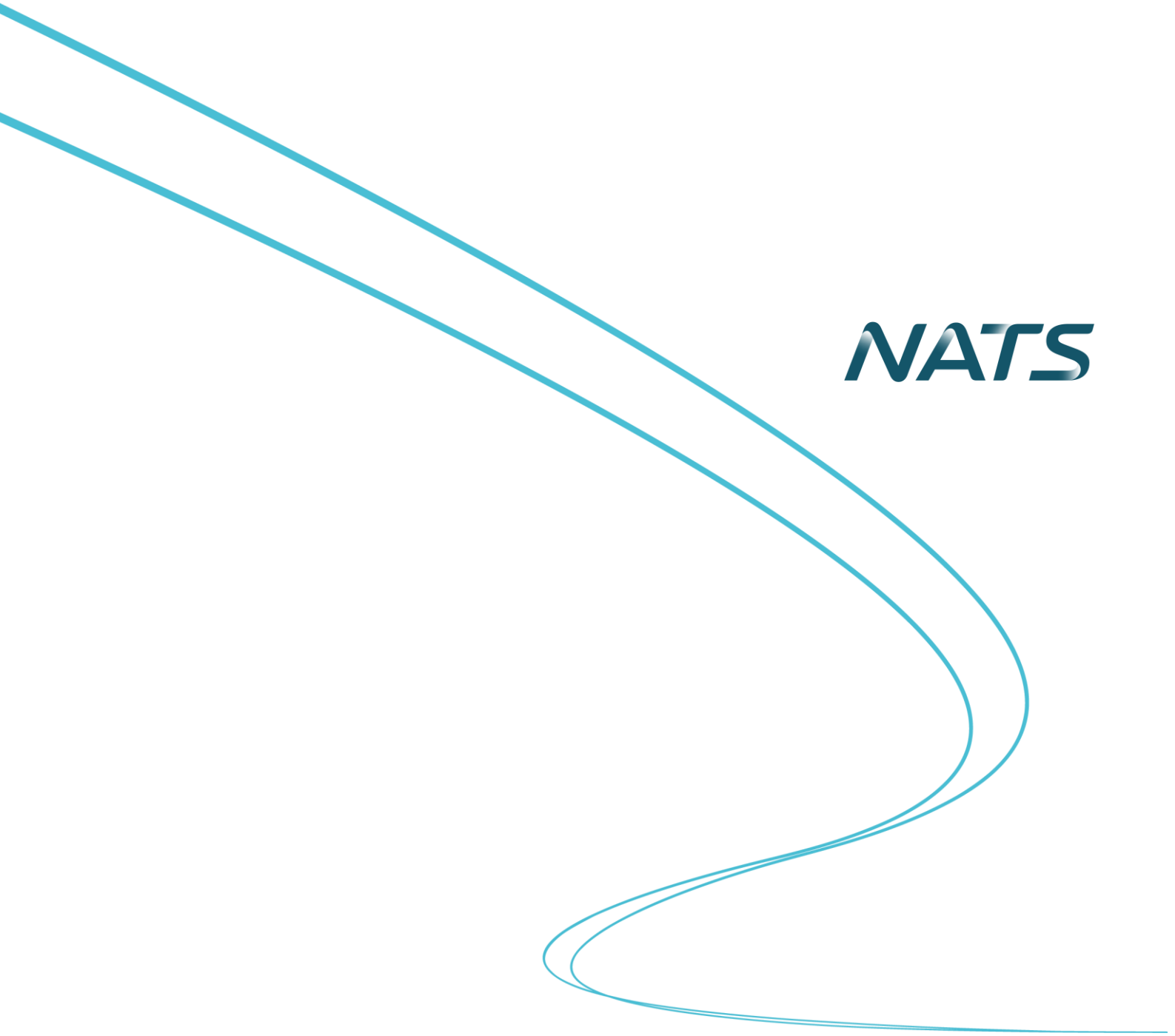
Free Route Airspace Deployment 1

Gateway documentation:
Stage 2 Develop and Assess

Step 2A document (i)
Airspace Change Design Options



Roles

Action	Role	Date
Produced	**Airspace Change Specialist** Airspace & Future Operations	14/06/2019
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Drafting and Publication History

Issue	Month/Year	Changes this issue
1.0	May 2019	Submitted to CAA for Stage 2 Assessment Gateway
2.0	June 2019	Revisions across all sections following comments from CAA. Resubmitted to CAA for Stage 2 Assessment Gateway.

Contents

References

1. Borealis Free Route Airspace Concept of Operations v1.0
2. EUROCONTROL European Route Network Improvement Plan (ERNIP) – Part 1: European Airspace Design Methodology - Guidelines - Edition December 2018 (Relevant sections: Section 6 Enroute Design Methodology, Sub-section 6.5: Free Route Airspace (FRA) Design)
3. CAA Airspace Modernisation Strategy (CAP 1711) (Relevant Sections: Upper Airspace Section 4)
4. ICAO Doc 7030, North Atlantic (NAT) Regional Supplementary Procedures

1. Introduction

1.1 This document forms part of the document set required in accordance with the requirements of the CAP1616 airspace change process.

1.2 This document aims to provide adequate evidence to satisfy Stage 2 Develop and Assess Gateway, Step 2A Airspace Change Design Options.

1.3 Free Route Airspace is defined[1] as "*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between a defined entry point and a defined exit point, with the possibility to route via intermediate (published or unpublished) way points, without reference to the ATS route network, subject to airspace availability. Within this airspace, flights remain subject to air traffic control.*"

1.4 The concept of Free Route Airspace (FRA) where aircraft can fly between points and are not constrained to follow a network of routes, is well established and has been recommended as a part of the Eurocontrol Single European Sky ATM Research (SESAR) programme and is a major initiative of the CAA's Airspace Modernisation Strategy (AMS). The implementation of FRA by European Union (EU) member states was mandated in European Law under the EU Implementing Regulation EU716/2014.

2. Options development – brief history

2.1 In response to SESAR PCP[2] Implementing Regulation EU716/2014, NATS intends to implement Free Route Airspace (FRA) in a phased manner across UK airspace. The SESAR PCP ATM Functionality 3 (AF3) states that Free Route shall be provided and operated in the airspace for which the Member States are responsible at and above Flight Level 310 in the ICAO EUR region (which includes the Scottish Upper Flight Information Region (UIR)) by 1st January 2022.

2.2 This ACP proposes the introduction of the first deployment of FRA across the majority of the Scottish FIR in order to comply with this Implementing Regulation within the required timescale.

2.3 Since this change is mandatory under EU law and an agreed strategic aim of the European Commission Single European Sky initiative, the options development has been limited to the following:

1) Baseline: do nothing – maintain the current high level ATS route structure.
2) Implement FRA in accordance with Implementing Regulation EU716/2014.

   FRA Option 1. In which all ATS routes are removed.

   FRA Option 2. In which the ATS route structure is partially maintained.

   FRA Option 3. In which the ATS route structure is maintained, but aircraft are not constrained to flight plan the routes within the FRA.

2.4 The scope of the first FRA Statement of Need submitted to the CAA which initiated the ACP process was to introduce FRA throughout the UK. Following the Assessment Meeting and initial work on Design Principles and options development, it became apparent that the scale of the ACP, in particular the length of time required to implement FRA in phased geographical deployments[3], did not easily align with the engagement and consultation requirements of the ACP process. Therefore the decision was taken to submit individual ACPs for each planned deployment of FRA. The first deployment is intended to introduce FRA across the majority of the Scottish Upper Information Region (UIR) airspace (as shown in Figure 4). This area of airspace was chosen due to its lower traffic complexity, the lack of dependency on simultaneous airspace modernisation projects (LAMP) traffic flow complexity, Borealis Alliance commitments and the requirements of neighbouring ANSPs.

[1] http://www.eurocontrol.int/articles/free-route-airspace

[2] The Single European Sky ATM Research (SESAR) Pilot Common Project (PCP) has been formalised in EU law under the Implementing Regulation EU716/2014. For more detail see Eurocontrol SESAR website.

[3] The implementation of FRA was assessed against influencing factors, such as system requirements, simultaneous airspace modernisation projects (LAMP, ScTMA etc) traffic flow complexity, Borealis Alliance commitments and the requirements of neighbouring ANSPs. The results of which necessitated a geographically phased implementation to enable the introduction of FRA within the PCP timescales.

2.5 The introduction of FRA is mandated under Implementing Regulation EU716/2014. Hence the design options for the implementation of FRA have been focused on meeting the requirements of the mandate. The system requirements[4] specified in the PCP will be delivered through the Deployment Point – En Route project which is being developed by NATS in parallel with the FRA project. Therefore system requirements are not considered within the long list options (although they may be referenced).

2.6 It should be noted that some of the legal requirements to implement FRA originate in EU law. It is NATS' position that due to wider commitments (e.g. Borealis Alliance) and the CAA Airspace Modernisation Strategy, it is the intention to introduce FRA regardless of the withdrawal of the United Kingdom from the European Union (EU).

3. Stakeholder Engagement

NATS has been actively involved in meetings and stakeholder engagement regarding how best to implement FRA for several years. Table 1 presents the stakeholder engagement meetings which have taken place.

Table 1 Stakeholder meetings

Date	Subject/*outcome*	Meeting with
19-20 August 2015	Borealis Alliance FRA Project Group, London	All Borealis Alliance members (Avinor, EANS, ANS Finland, IAA, ISAVIA, Latvijas Gaisa Satiksme (LGS), LFV, NATS, Naviair) for more information please click this link.
23-24 September 2015	Borealis Alliance FRA Project Group, Dublin	
27-28 October 2015	Borealis Alliance FRA Project Group, Oslo	
18-19 November 2015	Borealis Alliance FRA Project Group, Stockholm. *The above 4 meetings culminated in the agreement of the Borealis FRA Conops. (Ref 1) signed by the CEOs of all member ANSPs.*	
2015 – Present	Ongoing series of Borealis meetings. Initially 10 per year, now 4 per year.	
19th December 2017	FRA CONOPS Review *This meeting influenced the EUROCONTROL European Route Network Improvement Plan (ERNIP) – Part 1: European Airspace Design Methodology – Guidelines, which have in turn influenced the design option selection listed herein.*	EUROCONTROL
10th January 2018	Flight Plan Buffer Zones (FBZs) in FRA *Agreed the high level concept of FBZs and their application within FRA.*	CAA/EUROCONTROL
13TH February 2018	FRA Update. LIDO confirmed that NATS plans for FRA deployment were acceptable and presented no technical issues. This provided confidence that the proposed airspace design was operable. *Confirmed LIDO's acceptance of proposed FRA options*	Lufthansa Systems (LIDO)

[4] Requirements of the supporting ACT tools and engineering systems

14th February 2018	FRA Update. Sabre confirmed that NATS plans for FRA deployment were acceptable and presented no technical issues. This provided confidence that the proposed airspace design was operable. *Confirmed Sabre Data Services' acceptance of proposed FRA options*	Sabre Data Services
28th March 2018	FRA Update. British Airways confirmed that NATS plans for FRA deployment were acceptable and presented no technical issues. This provided confidence that the proposed airspace design was operable. *Confirmed BA's acceptance of proposed FRA options*	British Airways
2nd May 2018	FRA Update. Jeppesen confirmed that NATS plans for FRA deployment were acceptable and presented no technical issues. This provided confidence that the proposed airspace design was operable. *Confirmed Jeppesen's acceptance of proposed FRA options.*	Jeppesen
25th September 2018	FRA update and Design principle engagement.	DSNA Reims
5th October 2018	FRA update and Design principle engagement	EUROCONTROL network management
5th October 2018	FRA update and Design principle engagement	Jeppesen
16th October 2018	FRA update and Design principle engagement	IAA Shannon
23rd October 2018	FRA update and Design principle engagement	Naviair
4th December 2018	FRA update	CAA
15th January 2019	FRA update and options engagement (interface specifics)	Avinor
4th February 2019	FRA update and options engagement (interface specifics)	Maastricht UAC
27th March 2019	FRA update and options engagement (interface specifics)	Isavia
10th June 2019	FRA update and confirmation of agreement of options	Borealis Alliance Reykjavík

3.1 The first four meetings listed in Table 1, developed and agreed the Borealis Alliance FRA Concept of Operations (Ref 1). This outlines the agreed common concept of operations for FRA across the Borealis Alliance area. Agreement of this conops required extensive multi-way engagement between all nine Borealis members. The resulting conops influenced the design options listed herein (and in the Stage 2Aii options evaluation document). All stakeholders were polled by email in June 2019 as to whether they agreed with the design options. The responses all supported the design options presented and the selection of the preferred options.

3.2 Listed below are the stakeholders involved in the Design Principles and options engagement:

NATMAC
- BAE Systems
- Airlines UK
- British Business and General Aviation (BBGA)
- British Gliding Association (BGA)
- Low Fares Airlines
- MoD via DAATM

Data Houses/ Computer Flight-Plan Service Providers
- Jeppesen
- Lufthansa Systems
- Sabre

ANSPs
- Eurocontrol Maastricht Upper Area Control Centre (MUAC) FRA implemented 2017
- Eurocontrol Central Flow Management Unit (CFMU)
- Irish Aviation Authority (IAA) (Ireland) FRA implemented 2009
- Direction des Services de la Navigation Aérienne (DSNA) (France)
- DSNA ACC Brest (France)
- DSNA ACC Reims (France)
- NAVIAIR (Denmark) FRA implemented 2011
- Isavia (Iceland) FRA implemented 2018
- Avinor (Norway) FRA implemented 2015
- EANS (Estonia) FRA implemented 2015
- ANS Finland (Finland) FRA implemented 2015
- Latvijas Gaisa Satiksme (LGS) (Latvia) FRA implemented 2015
- LFV (Sweden) FRA implemented 2009
- RAF(U) Swanwick (UK Royal Air Force)

Table 2 below summarises the two-way stakeholder engagement on the FRA D1 design options. The references are to emails & meeting minutes which have been provided to the CAA as evidence.
This table shows which options have been influenced and how, by this engagement.

Table 2 Evidence of two-way stakeholder engagement

Stakeholder	Engagement date	Feedback	Influence on options	Ref*
Maastricht Upper Area Control Centre (MUAC)	04/02/2019	Meeting minutes. Maastricht Upper Area Control Centre (MUAC) has operated FRA since December 2017. In this meeting they gave the benefit of their experience of transitioning to and operating FRA. The meeting was a general exchange of experience and a status update on the development activities of the individual Free Route Airspace projects of Maastricht UAC (FRAM) and NATS in the fields of: • Project Management • Key lessons learnt from FRAM projects • Safety case activities • Airspace Design principles • PBN and Route/Track conformance • RAD complexity and CFSPs • Airspace management and FRA – pre tactical and tactical • Coordination of future activities` • MUAC planning timescales for final FRA introduction • Key lessons learnt from FRA deployments	1, 4, 8, 9	MUAC1

	04/02/2019	NATS minutes of MUAC meeting. Overview of FRA Deployment 3 (H24 – Dec'19) • All DCTs will be removed • Some Routes will be retained to maintain safety and capacity • Where routes are removed the FRA limitations will replicate the current traffic orientation. FRA limitations adjusted to remove sector clipping where necessary • Major flows will remain as they are currently • Majority of FRA Entry and Exit COPs are on FIR boundary- exception being FIR Boundary with Germany due to airspace delegations • Profile Tuning Restrictions (PTRs) have been adjusted to ensure vertical connectivity to FRA is available for Flight Planning • Design will be forwarded to all ANSPs partners (including NATS) for comment on the proposed design. Comments to be returned by early May'19 • All FRA deployments have been designed through safety assessments, ATCO design workshops and Real Time Simulations (RTS) • The design process has used different ATCOs for each stage of the design and safety process. Using the same ATCO groups for each safety and design process to ensure continuity over all stages • The last RTS involved 11 Sector Groups over 2 days • The previous deployments (Dec'17 – Night FRA, Dec'18 – Night and Weekend FRA) have involved half day real time simulation (RTS) and computer based training (CBT) per ATCO • The Dec'19 H24 deployment will only involve CBT as ATC experience has been built up. • Flight Plan Buffer Zones (FBZs) will be introduced to provide 5nm flight planned route separation from Special Use Airspace (SUA) – keeps simplicity, efficiency of airspace design due to varying tactical ASM protocols within MUAC AoR. Advised to design FBZs accurately, particularly the corners. • LARA – Dutch Mil already use LARA and real time LARA picture is displayed to Sector controllers HMIs. Belgian Mil will be connected with real time picture in Q1 2020 • EU restrictions, managed in the RAD, are used to facilitate SUA booking on the day of operation (Procedure 3). This forces traffic to flight plan around the SUA if their departure aerodrome is in excess of either 3 hours, or 5 hours (dependent on the State SUA booking requirements) flying time from the SUA regardless of the activation status promulgated in the AUP. For MUAC, the 5 hour option was preferable to simplify the associated RAD restriction.	1 4, 3 3,4 8, 9	MUAC2
	13/03/2019	Cross-border routes/coordination (email)	3,4,9	MUAC3
	10/05/2019	MUAC-FRA coordination	1,2,3,4,7,8,9	MUAC4
Eurocontrol	11/01/2019	Eurocontrol meeting minutes	1, 4, 8, 9	ECTL1
	21/02/2019	ENAV NPZ	4, 8	ECTL2
Avinor	15/01/2019	Meeting notes.	1, 4, 8, 9	Avinor1
	23/03/2019	Meeting coordination, ATC aspects	1, 4, 8, 9	Avinor2
	04/12/2018		9	Avinor3
	21/01/2019	Feedback from meeting	1, 4, 8, 9	Avinor4
IAA	16/10/2018	Meeting notes.	1, 4, 8, 9	IAA1
	22/03/2019	Schedule of meetings		IAA2
	23/08/2018	Boundary COPs	4, 8, 9	IAA3

	18/12/2018	Interface questions	1, 4, 9	IAA4
Isavia	17/01/2019	Meeting logistics		Isavia1
	27/03/2019	Presentation	1, 4, 8, 9	Isavia2
	12/06/2019	Email confirming agreement of design options	all	Isavia3
Naviair	25/10/2018	Positions of Danish Danger areas	4, 8, 9	Naviair1
	26/10/2018	SUA positions, lat long positions	1, 4, 8 9	Naviair2
	15/02/2019	FDP OLDI	9	Naviair3
	20/05/2019	OLDI interface	1, 9	Naviair4
	16/05/2019	Cross-border FRA	9	Naviair5
	08/02/2019	COP issues, lat long positions	1, 9	Naviair6
	24/07/2019	Delegated airspace, cross border FRA	4, 8, 9	Naviair7
	12/06/2019	Email confirming agreement of design options	all	Naviair8
	12/06/2019	Email confirming agreement of design options	all	Naviair9
Sabre	12/06/2019	Email confirming agreement of design options	all	Sabre1

* References as supplied to CAA

3.3 This section demonstrates two-way engagement with appropriate stakeholders. Tables 1 and 2 indicate where option decisions were influenced by engagement with stakeholders. Ongoing engagement continues via direct email and/or phone contact.

4. Simulations

Two real time simulations of FRA concepts and design options have been undertaken by NATS over a total of eight days.
16-20 April 2018 (Prestwick Centre)
24-26 April 2019 (Prestwick Centre) Attended by RAF(U) Swanwick

These simulations have served to inform opinions of the different options and provide hands-on experience for air traffic controllers such that different options can be evaluated. This experience has been fed-back into the qualitative assessments as recorded in the options matrices in the accompanying Stage 2aii options evaluation document.

5. Baseline (do nothing) description

The following pages describe the baseline (do nothing) scenario.
It should be noted that "Doing nothing" is useful as a baseline for comparison, but due to the PCP mandate it is not considered as a viable option.

5.1 Current airspace diagrams

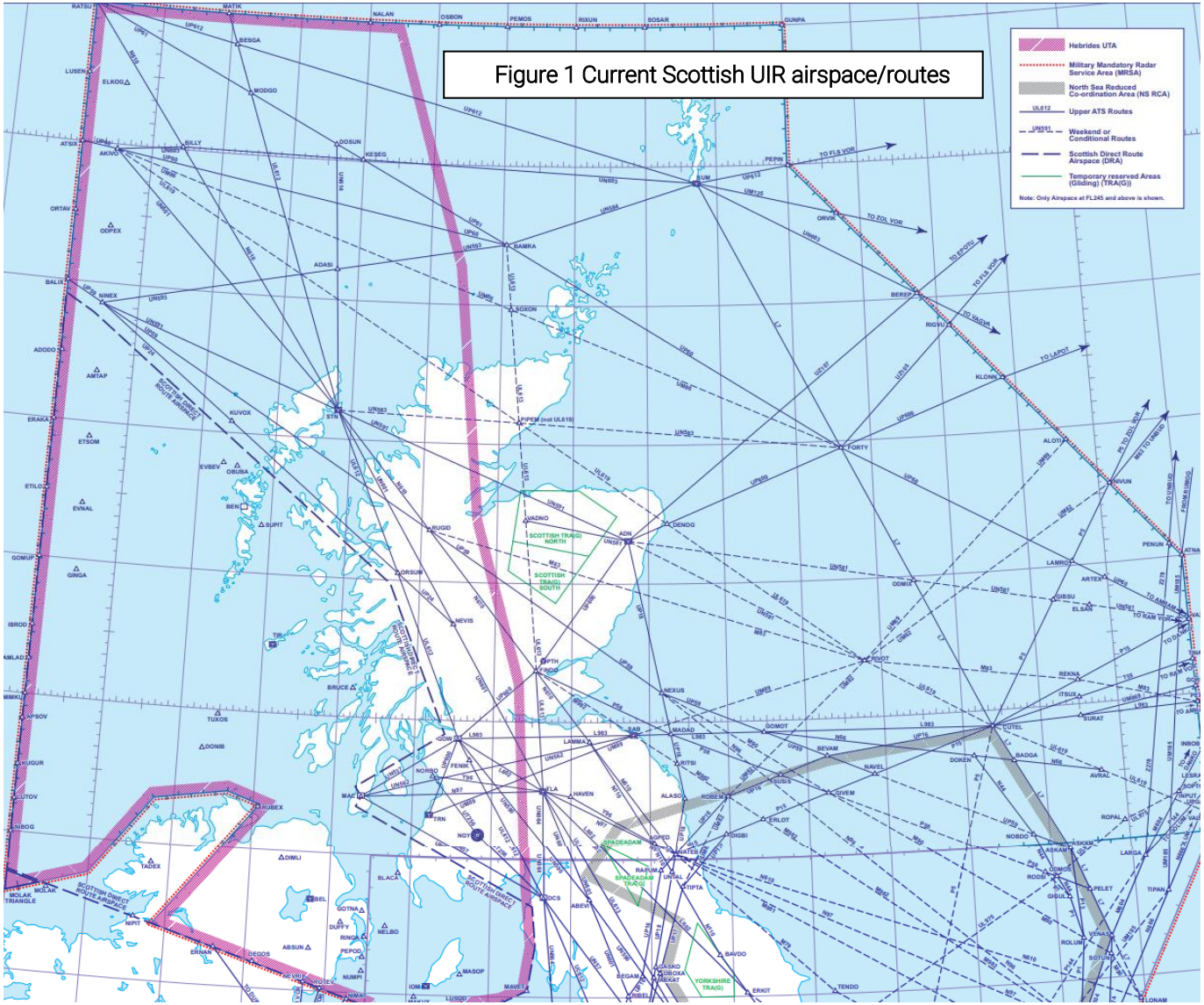


Figure 1 Current Scottish UIR airspace/routes

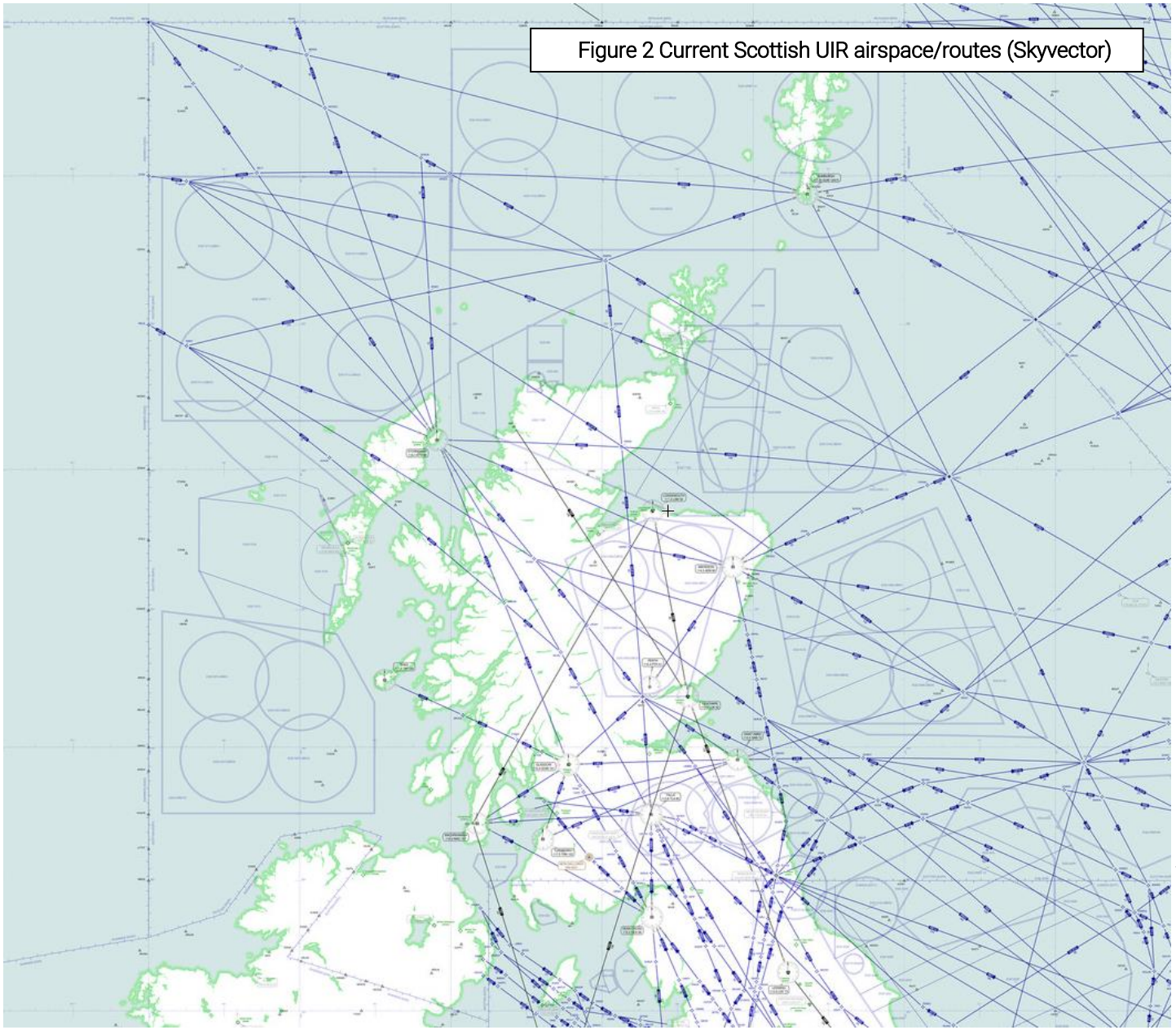


Figure 2 Current Scottish UIR airspace/routes (Skyvector)

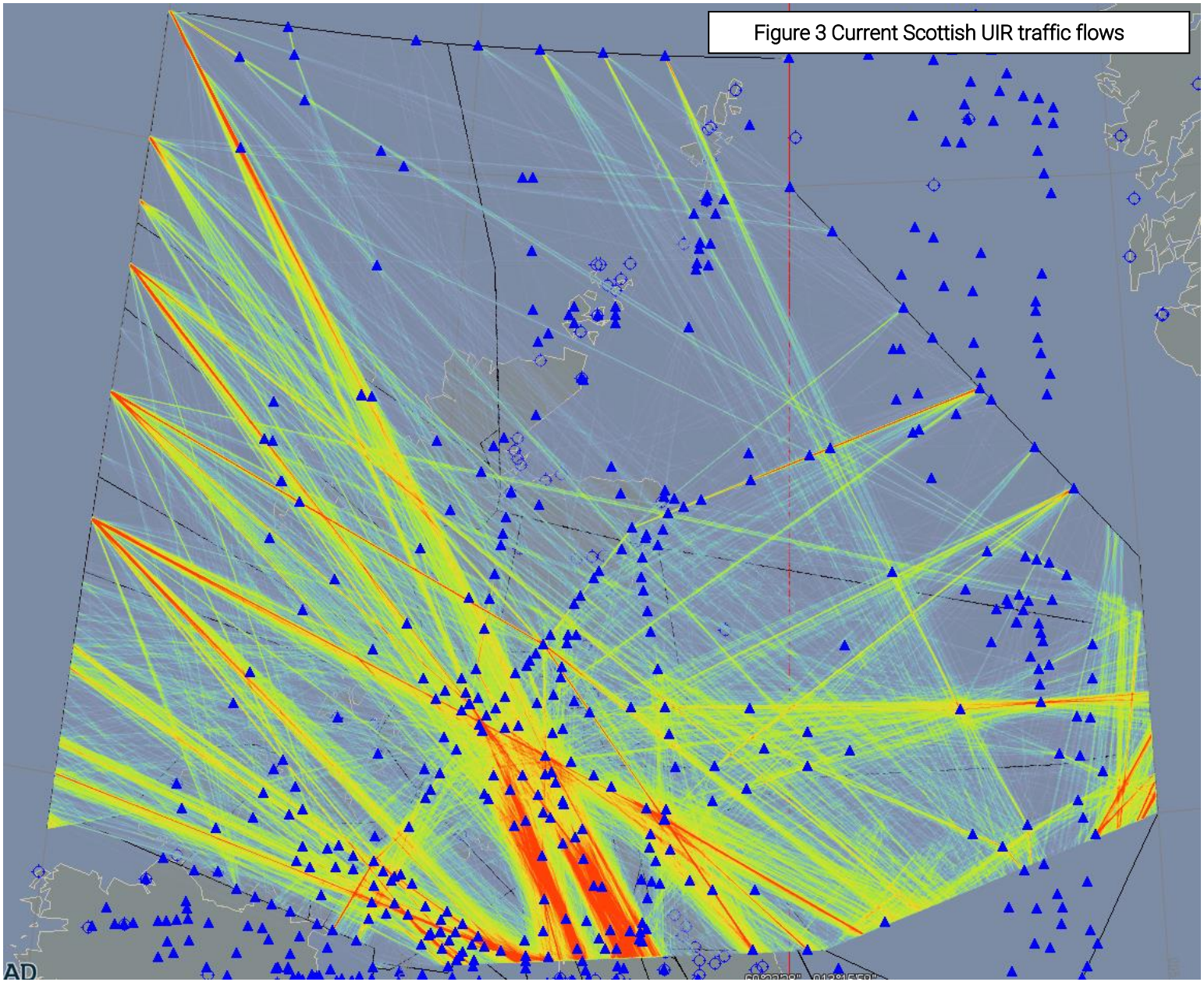


Figure 3 Current Scottish UIR traffic flows

5.1.1 Figure 1 & 2 show the current Scottish Upper information Region (UIR) airspace and Upper Air Traffic Service (ATS) route network. Note the Scottish Direct Route Airspace (DRA) to the west of the Scottish mainland is shown in Figure 1 (outlined by long dashed lines). This DRA is an existing precursor to FRA where the ATS route structure has been removed and aircraft can fly published direct routes between designated entry/exit points.

5.1.2 Figure 3 shows current flight-path density plots (2018 data). This shows the typical flows of traffic in the upper airspace.

5.1.3 Currently all aircraft flight plan to fly along the published ATS route structure (or in the DRA, on published Directs (DCTs), which are trajectories between specified waypoints). The ATS route structure is based on ground based navigation beacons, many of which are being withdrawn from service. Modern satellite navigation now makes navigation between any points possible and there is much less reliance on ground-based navigation beacons. As such it is now common-place for air traffic control (ATC) to allow aircraft to route direct to a point (termed a tactical direct), to improve efficiency as aircraft transit through UK airspace. The use of the designated entry/exit points (termed coordination points (COPs)) at the UIR boundary, and the influence on flight-paths of some navigation beacons and the ATS route structure can be seen clearly in Figure 3. However the regular use of tactical direct shortcuts to/from the COPs can also be discerned. The points where traffic converges on the western boundary are oceanic entry and exit points, where transatlantic flights join the oceanic route structure.

5.1.4 For reference the extant UK route structure is defined in detail in the UK AIP
ENR 3.2 UPPER ATS ROUTES
ENR 3.3 AREA NAVIGATION ROUTES

6. FRA Concept Overview

6.1.1 FRA is defined as "*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.

6.1.2 Deployment of FRA is a legislative requirement of the SESAR Pilot Common Project (PCP) ATM Functionality 3 (AF3) Implementing Rule. The SESAR PCP AF3 requires ANSPs to implement FRA, at FL305+, by 1st January 2022.

6.1.3 Within FRA air traffic will be able to flight plan user preferred trajectories without reference to a route structure, therefore flows of traffic are able to change hour by hour, month by month and year by year in a manner which is not constrained by airspace design and is therefore unpredictable. Short and long term factors which can have an influence on the routings chosen by aircraft operators include:

short term factors

- weather/winds (jet stream position),
- industrial action
- events such as large sporting events (e.g. football matches, Olympics etc)
- military activity
- ATC traffic regulations (used to manage flows)

long term factors:

- relative route charges between neighbouring countries,
- fuel prices,
- company business models/ fleet mix
- seasonal route preferences,
- changing destinations and emerging markets,
- political factors
- tourism preferences/marketing/fashion.

6.1.4 FRA is also expected to facilitate flight planning and fuel benefits which will contribute to the UK Ireland FAB Performance Plan & UK Airspace Modernisation Strategy (AMS).

6.1.5 In addition, NATS has committed to the Borealis Alliance area of FRA. Borealis members (see Table 1) have committed to put in place a seamless and integrated FRA extending across national airspace boundaries from the eastern boundary of the North Atlantic to the western boundary of Russian airspace in the North of Europe.

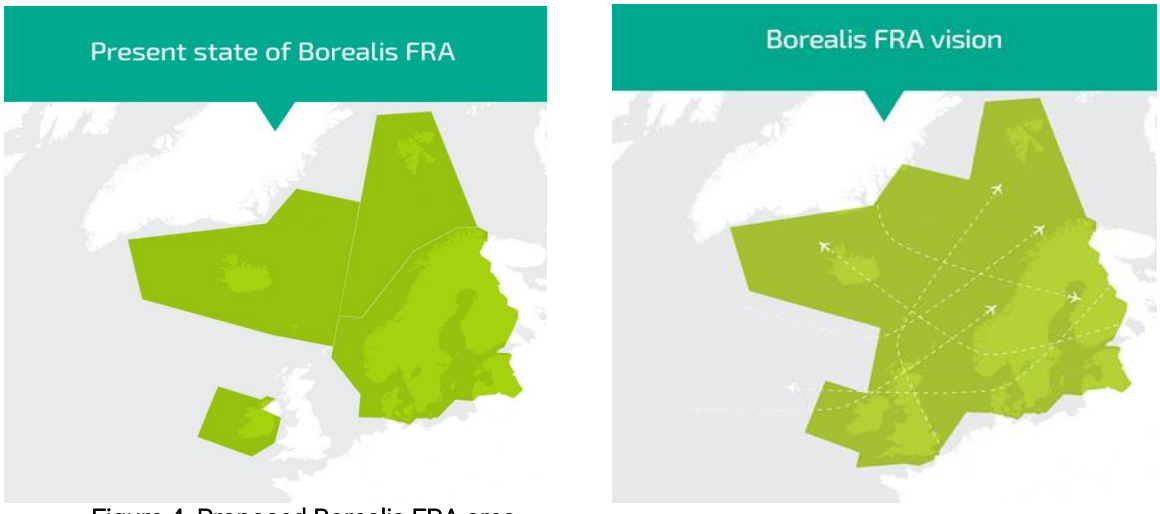


Figure 4 Proposed Borealis FRA area

6.1.6 The intention of the cross-border FRA concept is to secure unconstrained cross-border FRA operations at the ANSP interfaces, in accordance with the Eurocontrol European Route Network Implementation Plan (ERNIP Part 1) (ref 2) and North Atlantic Documents e.g. ICAO Doc 7030.

6.1.7 This concept will provide the possibility for airspace users to flight plan a preferred trajectory, regardless of national FIR boundaries, and portions of airspace within which ATS is delegated to the participating states.

6.1.8 The Borealis Alliance membership have worked cooperatively over many years to develop a common FRA concept of operations as outlined in the Borealis Free Route Airspace Concept of Operations v1.0 (Ref 1). Many of the design options discussed in the Stage 2 document set are related to, and have been influenced by the engagement between Borealis Alliance members and other ANSPs and stakeholders.

6.2 FRA- Concept Options

6.2.1 The principal FRA concept with sub-options is discussed in this section. Figure 5 shows the FRA area which is under consideration for Deployment 1.

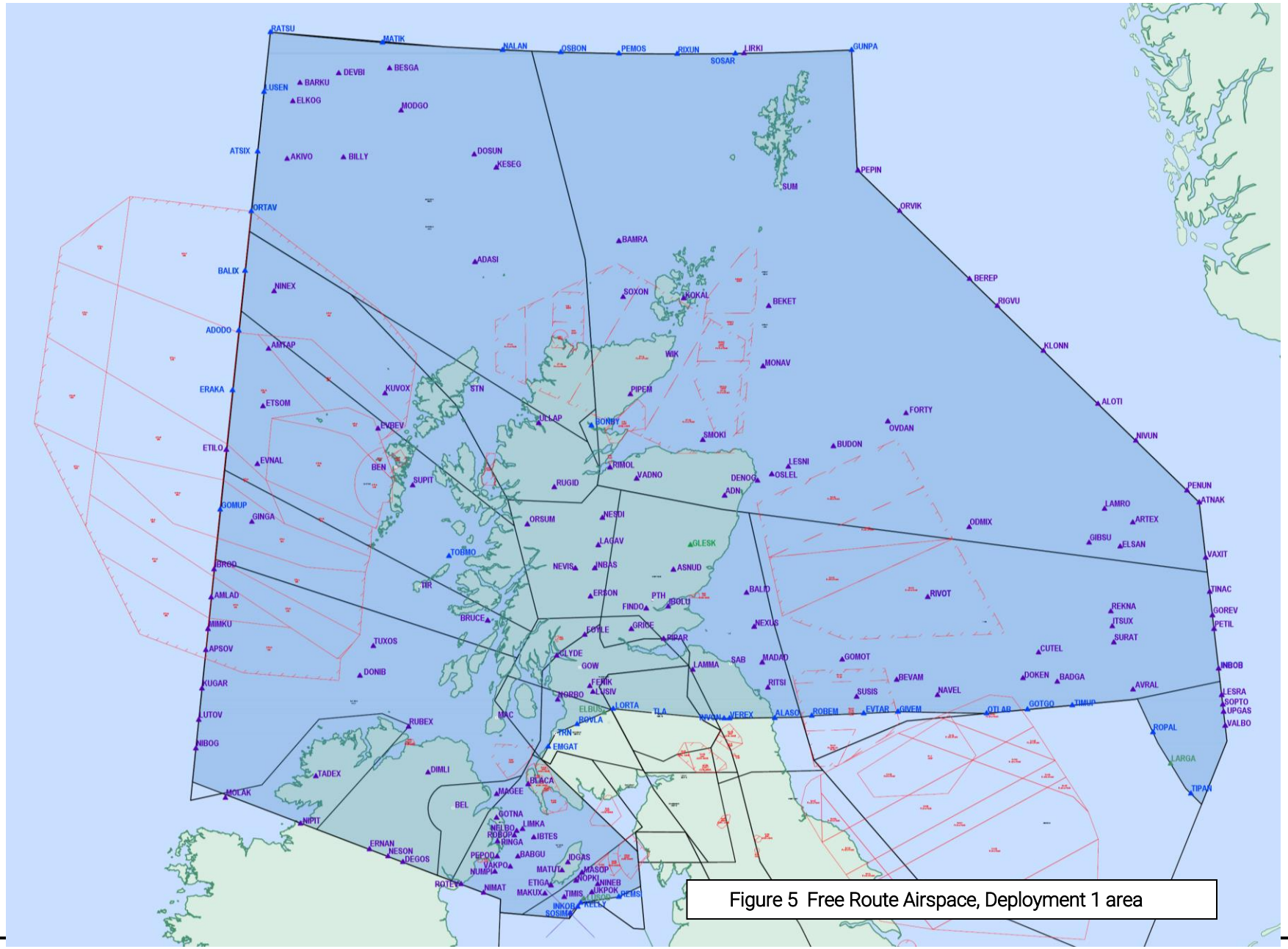


Figure 5 Free Route Airspace, Deployment 1 area

The design options considered for each of the FRA mandated requirements are discussed below in detail. Combinations of these are then considered to construct full design options for the FRA concepts to be progressed.

6.3 PCP Requirement 1: Free Route may be deployed both through the use of Direct Routing Airspace (see section 5.1.1) and through FRA.

Option 1.1: Deploy FRA using DCT only. This introduces constraints due to having to file published direct routings (DCTs). Hence the user cannot define direct route segments themselves. These constraints limit the benefit of FRA to the airspace users, hence this is not a preferred option. Also due to system constraints, over a large area where all possible permutations of DCTs have to be incorporated, the number of permutations becomes increasingly challenging for flight data processing systems to handle. For this reason this option is not considered feasible.

Option 1.2 (preferred): Deploy FRA using unpublished DCTs. This provides the most flexible form of FRA since it enables flights to be planned between any published or unpublished points anywhere within the airspace. This is in accordance with the Borealis FRA Conops (Ref 1), and the Eurocontrol FRA Airspace Design Methodology Guidelines (Ref 2).

The selection of Option 1.2 as the preferred Option was influenced by engagement with the eight other Borealis Alliance member ANSPs in the development of the Borealis FRA Conops (Ref 1), plus Eurocontrol in the engagement regarding the Eurocontrol FRA Airspace Design Methodology Guidelines (Ref 2).

6.4 PCP Requirement 2: To facilitate early implementation before the target deployment date, free route could be implemented in a limited way during defined periods

Option 2.1: Initially deploy FRA night time only. This would limit the benefit of FRA to airspace users, since it would only be operated during quieter traffic periods. Also it requires twice daily transitions between the FRA concept of operations and the fixed route concept which introduces complexity for Network management (NM), ANSPs and airspace users. This complexity causes flight planning issues for pilots and aircraft operators' flight planning. Hence this is not a preferred option.

Option 2.2: Initially deploy FRA night time and weekends only. This would limit the benefit of FRA to airspace users, since it would only be operated during quieter traffic periods. Also it requires several transitions throughout the week, between the FRA concept of operations and the fixed route concept which introduces complexity for NM, ANSPs and airspace users. This complexity causes flight planning issues for pilots and aircraft operators' flight planning. Hence this is not a preferred option.

Option 2.3: (preferred) Deploy FRA H24. Introduction of FRA full time, 24 hours per day, will give the greatest benefit to aircraft operators by allowing the use of user preferred trajectories at all times. It also removes the necessity for transitioning between fixed route and free route operations, hence the complexity for ATC and pilots is less than for options 2.1-2.3. Also the overhead of maintaining the ATS route network (which is no longer necessary) is removed. For these reasons this is the preferred option.

The selection of 2.3 as the preferred Option was influenced by engagement with the eight other Borealis Alliance member ANSPs in the development of the Borealis FRA Conops (Ref 1), plus Eurocontrol in the engagement regarding the Eurocontrol FRA Airspace Design Methodology Guidelines (Ref 2). The experience of other ANSPs confirmed that H24 FRA deployment was the best, with other options being more complex.

6.5 PCP Requirement 3: Procedures for transitioning between free route and fixed route operations shall be set.

Option 3.1: Mandate FRA entry and exit points as Coordination Points (COPs) on the UIR boundary. This is similar to the extant structure where borders are usually crossed at the designated COPs. This introduces constraints due to having to fly between fixed COPs on the UIR boundaries which the user cannot define themselves. These constraints limit the benefit of FRA, and are not in accord with the true cross-border FRA concept which NATS has agreed with its Borealis Alliance partner ANSPs. Hence this is not a preferred option.

Option 3.2: Extend STARs into FRA volume. Standard Terminal Arrivals (STARs) are arrival procedures to specific airports. However STARs could extend into the FRA volume ensuring a coherent planning connectivity between systemised airspace and FRA. This is feasible.

Option 3.3: Extend routes into FRA volume to a FRA entry/exit point to cater for a variety of aircraft performance profiles. Aircraft descending down from FRA into the lower airspace and the lower ATS route network will do so by joining a lower ATS route. Those climbing up into FRA from the lower airspace and the lower ATS route network will do so by leaving a lower ATS route and climbing into the FRA. By extending some of these lower ATS routes into the FRA airspace, this will permit more predictable flow of traffic and will cater for a wide range of aircraft performance profiles. This is feasible, however since it introduces published constraints it is not the preferred option.

Option 3.4 (preferred): Use the Route Availability Document (RAD) restrictions to manage the flow of traffic transitioning into and out of FRA. The flow of aircraft descending down from FRA into the lower airspace can be restricted in the RAD (by destination). Those climbing up into FRA from the lower airspace and the lower ATS route network will also be restricted in the RAD to do so at specific points.

The selection of Option 3.4 as the preferred option was influenced by the experiences of other ANSPs, who are already operating FRA. In addition Eurocontrol, through the ERNIP Part 1, describe how the RAD will manage these aspects of the FRA airspace design.

6.6 PCP Requirement 4: Initial implementation of Free Route may be done on a structurally limited basis, for example by restricting the available entry/exit points for certain traffic flows, through the publication of DCTs, which will allow airspace users to flight plan on the basis of those published DCTs.

Option 4.1: Maintain the ATS route structure within FRA. Experience from other ANSPs has indicated that this is a viable option and could be used as a transitional arrangement to assist airlines where they prefer to continue to flight plan using the existing route structure. However this does carry an overhead to maintain the ATS route structure, and is not aligned with the longer term goal of removing all routes. It does however meet the PCP requirement. Hence whilst this is not the preferred option, it is viable and could be used as a transitional arrangement. As such it will be carried forward as an option.

Option 4.2: Remove the ATS route structure within FRA. This represents the purest implementation of FRA and is the long term goal. It should be noted that EUROCONTROL are promoting removal of the ATS route network.

Option 4.3 (preferred): Remove the ATS route structure but retain waypoints, which may be mandated for certain trajectories within the RAD to manage traffic flows. The use of RAD restricted intermediate points is an option where systemisation is necessary to help deconflict traffic in areas of high flight density and to manage levels of complexity created by flows of traffic into and out of airfields. However the more RAD restrictions that are introduced, the further the operation gets from true FRA. This is an option which could be called upon to assist with systemisation in areas of high traffic complexity to preserve capacity. This is viable as an option, and though a departure from the "pure" FRA concept, may be necessary to manage complex traffic flows.

Option 4.4: Partially remove the ATS route structure within FRA. This option is a compromise halfway between 4.1 and 4.2. As such it has the same disadvantages as 4.1 but on a proportional sliding scale. This is viable, but not preferred.

Option 4.5: Publish all available DCTs within FRA in the RAD and maintain the current DCT planning restrictions, which will limit flight plan options to only published DCTs. This is similar to how the extant Direct Route Airspace (DRA) in the Scottish UIR was implemented. However this would only be required as a work-around to address limitations in the legacy flight data processing (FDP) system. The introduction of a new FDP system and ATC toolset will remove this limitation. Hence this is not preferred.

Option 4.6 (preferred sub-option): Designing No Planning Zones (NPZ) or enhanced use of Flight plan Buffer Zones (FBZ) to manage traffic flows. See Appendix A for a description of FBZ and NPZ. The use of NPZ (areas where a flight plan is not permitted to enter at all or only when meeting prescribed criteria) will be considered. NPZs may provide a solution to managing complexity without the need for multiple

RAD restrictions. This is an additional sub-option which could be called upon to prevent disproportionate workload resulting from routing through certain areas.

The selection of Option 4.3 as the preferred Option was influenced by engagement with the eight other Borealis Alliance member ANSPs in the development of the Borealis FRA Conops (ref 1), plus Eurocontrol in the engagement regarding the Eurocontrol FRA Airspace Design Methodology Guidelines (ref 2). The experience of other ANSPs confirmed that keeping the ATS route structure (option 4.1) should be kept as an option as a transitional arrangement. The use of FBZ & NPZ (option 4.6) should also be considered as a way of managing SUA avoidance, avoiding sector clipping[5] and other undesirable flight plan scenarios.

6.7 PCP Requirement 5: DCT availability may be subject to traffic demand and/or time constraints.

Option 5.1 (preferred): Partial or complete limitation of DCT availability in the RAD.

It may be necessary to constrain availability of specific trajectories or airspace in order to ensure traffic complexity remains at a manageable level. Such constraints in DCT availability will be managed by the RAD.

Option 5.2: Enable DCT to be flight planned whenever required.

This precludes the option to use the RAD to introduce constraints in DCT availability. Whilst it offers the airspace user unconstrained access to the airspace it does introduce the likelihood that ATC will encounter increasing levels of complexity which may need to be mitigated by capacity constraints.

The selection of Option 5.1 as the preferred option was influenced by the fact that it is highly likely some structural limitations will be required to help systemise traffic flows in FRA operations in the UK. This is a realistic and pragmatic approach to delivering maximum benefits to airspace users without negatively impacting capacity.

6.8 PCP Requirement 6: Free Route shall be provided and operated in the airspace for which the Member States are responsible at and above Flight Level 310 in the ICAO EUR region.

Note Options 6.1 & 6.2 below address the vertical limits and 6.3 & 6.4 concern the lateral limits of proposed FRA. As such these are not mutually exclusive.

Option 6.1: Introduce FRA at FL305 and above without structural limitations. This does not easily align with the extant ATC sectorisation and would hence introduce additional levels of complexity to the ATM operation. The extant base of many upper ATC sectors[6] varies and can be as low as FL255. For a sector to have a mix of FRA and fixed ATS routes at different altitudes would introduce an unacceptable degree of complexity. Hence this option of a uniform base level of FRA across the airspace is not considered viable.

Option 6.2 (preferred, vertical): Introduce FRA at FL305 and above as a minimum; enabling FRA to be introduced at lower levels where deemed appropriate and manageable. This permits alignment with the ATC sectorisation such that, as far as possible, all of an air traffic control sector is either utilising FRA or fixed ATS routes. This is also in the spirit of full FRA, introduces FRA in the greatest volume of airspace practical thereby delivering increased benefits to airspace users. Hence this is preferred.

Option 6.3: Introduce FRA laterally across all UK airspace simultaneously. The implementation of FRA across all UK upper airspace simultaneously would carry a high risk due to the complexity of air traffic interactions, especially in the airspace above London. Hence this option is not considered feasible.

Option 6.4 (preferred, lateral): Sequence the lateral introduction of FRA within UK airspace. If the *permanent* implementation of FRA were laterally limited it would restrict the benefits of FRA. Hence the *end* goal is for FRA to extend laterally across the entire UK airspace. The logistics of implementing this have however necessitated the separate deployments, each having its own ACP. This ACP covers FRA

[5] E.g. Where the corner of an ATC sector may be crossed and the aircraft is thus only in the sector briefly.
[6] A sector is the volume of airspace controlled by an individual air traffic controller

Deployment 1, which is planned to be limited laterally. This method allows for the progressive introduction of FRA across the entire UK airspace in a phased manner and is a temporary transitional arrangement. Hence this option is feasible (and is being progressed as an interim measure). The long-term goal is for UK-wide FRA, however this will be completed by additional subsequent FRA ACPs.

The selection of Option 6.2 as the preferred option for vertical considerations was influenced by engagement with the eight other Borealis Alliance member ANSPs in the development of the Borealis FRA Conops (Ref 1), plus Eurocontrol in the engagement regarding the Eurocontrol FRA Airspace Design Methodology Guidelines (ref 2). The experience of other ANSPs confirmed that extending FRA to lower levels especially where it facilitates uniformity of operations within a sector is advantageous and reduces complexity.

The selection of Option 6.4 as the preferred option for lateral considerations was influenced by engagement with the CAA, and the requirements of the airspace change process. This resulted in the decision to separate each deployment into an individual ACP (each laterally limited to a portion of UK airspace).

6.9 PCP Requirement 7: Network Manager, air navigation service providers and airspace users shall operate: — DCT as from 1 January 2018 — FRA as from 1 January 2022.

Option 7.1 (preferred): Deploy FRA in UK airspace by 1 January 2022. It is the intention of this ACP to deploy FRA across the Deployment 1 area by 1 January 2022. This is also in accordance with commitments to the Borealis Alliance FRA Programme.

Option 7.2: Deploy FRA at a time most suited to business needs. Whilst it may be cheaper to delay the deployment of FRA, NATS are committed to deployment before 1 January 2022, hence this is not a preferred option.

The selection of Option 7.1 as the preferred option was influenced by engagement with the eight other Borealis Alliance member ANSPs and NATS has made a commitment to the Borealis Alliance to this effect.

6.10 PCP Requirement 8: Flight planned trajectories will need to be managed to maintain a safe distance from SUA

Option 8.1: Establish Flight plan Buffer Zones (FBZs) around Special Use Airspace (SUA) (such as military danger areas) within FRA (See Appendix A for description of FBZs). FBZs would be published around the SUA such that flight plans received by the central flight planning system IFPS would be rejected and would require to be re-filed by the aircraft operator. Intermediate Points may be published for flight planning around the FBZ/SUA. This is not being progressed since there is a risk that aircraft could flight-plan below the SUA and inadvertently climb into it.

Option 8.2 (preferred): Establish FBZs around SUA within FRA and the systemised airspace below. As per 8.1 but with the FBZ extending lower (below the FRA) if necessary.

Option 8.3: Mandate waypoints within FRA around SUA in the RAD. Mandating waypoints around SUA in the RAD is feasible and could deliver benefits to the FRA operation. However consideration needs to be given to any additional complexity introduced; it would also remove the ability for the airspace user to choose the most optimal route. Hence this is not considered optimal and is not preferred.

Option 8.4: Maintain the ATS route structure around SUA. This does not align with the goal of pure FRA. Maintaining routes just around the SUA is not considered feasible due to the complexity of having a mixture of mandated routes and FRA in the same airspace.

The selection of Option 8.2 as the preferred option was influenced by engagement with the CAA, Eurocontrol, MoD and eight other Borealis Alliance member ANSPs.

6.11 Requirement 9 (Borealis): Cross Border FRA.

Option 9.1: Constrain cross border flight plans to file via a COP on the UIR boundary. This is similar to extant operations, however it limits the benefit of FRA and would result in sub-optimal trajectories and continued bunching of traffic at coordination points; hence it is not preferred.

Option 9.2: Unconstrained cross border flight plans. This option assumes that agreement is secured with ALL of the adjacent ANSPs; that they can handle unconstrained cross-border flights. This requires them to have the appropriate infrastructure in place. (Note: The boundary between Prestwick & Reykjavik will not be cross border initially. Isavia are considering it, but since Icelandic airspace is oceanic and therefore operated procedurally i.e. without reference to surveillance data, it comes with some constraints.)

Option 9.3 (preferred): Unconstrained cross border flight plans where agreed with neighbouring States (partial cross border FRA). Agreement has to be made with the adjacent ANSP that they can handle unconstrained cross-border flights. This requires them to have the appropriate infrastructure in place. Hence this option recognises this external constraint. NATS will do what it can to implement cross border FRA subject to any limitations required by neighbouring states[7]. This is in accordance with the Borealis Conops (Ref 1), and the Eurocontrol FRA Airspace Design Methodology Guidelines (Ref 2).

Option 9.4: Introduce intermediate points near boundary that allow cross border FRA but constrain routings. This is not in the spirit of FRA and is contrary to the Borealis Conops (Ref 1). It introduces constraints which would limit the benefit of FRA for airspace users. Hence this is not preferred.

The selection of Option 9.3 as the preferred option was influenced by engagement with the eight other Borealis Alliance member ANSPs, and DNSA (French) and MUAC. Isavia are unable to support cross-border FRA at the proposed Deployment 1 implementation date. Hence this ruled out option 9.2 and resulted in 9.3 being the preferred option.

7. Conclusion and Next Steps

7.1 NATS have engaged with appropriate ANSPs, coding houses, airlines, MoD, and GA stakeholders, resulting in comprehensive discussions on the possibilities for FRA implementation.

7.2 There are a number of potential component permutations of route structures, airspace boundaries, buffer zones and no flight planning zones. It would be disproportionate at this stage to attempt to fully describe every possible component permutation.

7.3 In this document we have described the options for fulfilling the PCP requirements, which have been explored with our stakeholders.

7.4 The next document, Step 2A(ii), will evaluate the design options listed in this document, reducing the longlist to a shortlist for appraisal.

[7] For example one ANSP may require that COPs are retained on their border only.

8. Glossary of Terms

ACP: Airspace Change Proposal

ANSP: Airspace Navigation Service Providers

ATC: Air Traffic Control

ATS: Air Traffic Services

Baseline: 'As is' situation against which proposed changes are measured

Borealis Alliance: Alliance amongst north-west European Air Navigation Service Providers to drive better performance for stakeholders through business collaboration. The Alliance includes the ANSPs of Denmark, Estonia, Finland, Iceland, Ireland, Latvia, Norway, Sweden and the UK.

CAA: Civil Aviation Authority

CAP: Civil Aviation Publication (publications produced by the CAA)

CONOPS: Concept of operations

DCT (Direct): Waypoint to waypoint routing, which does not use an airway.

Eurocontrol: European Organisation for the Safety of Air Navigation; with 41 members it seeks to achieve safe and seamless air traffic management across Europe.

FBZ: Flight Plan Buffer Zones – areas for flight planners to avoid to provide separation from Special Use Airspace.

FL: Flight level, the altitude reference which aircraft use at higher altitudes using standard pressure setting, essentially units of 100ft, i.e. FL245 equates approximately to 24,500ft

FRA: Free Route Airspace

ICAO: International Civil Aviation Organisation – an agency of the United Nations.

NPZ: No Planning Zones – areas where a flight plan is not permitted to enter at all or only when meeting prescribed criteria.

Scottish FIR: Scottish Flight Information Region (Airspace below FL245)

Scottish UIR: Scottish Upper Information Region (Airspace above FL245)

Single European Sky ATM Research (SESAR): A collaborative project to completely overhaul European airspace and its air traffic management

LAMP: London Airspace Modernisation Programme; established to redesign the airspace in and around the London TMA region, providing a more efficient airspace design, modernising the route structure and making better use of aircraft and ATC technologies.

NATMAC: National Air Traffic Management Advisory Committee

NM: Network Management

PBN: Performance Based Navigation – international requirements which standardise accuracy, safety and integrity for satellite navigation systems.

RAD: Route Availability Document: contains the policies, procedures and descriptions for route and traffic orientation. Includes route network and free route airspace utilisation rules and availability.

SUA: Special Use Airspace – areas designated for operations of a nature that limitations may be imposed on aircraft not participating in those operations (i.e. military training areas)

Systemised airspace: Use of procedure based methods used to manage aircraft rather than tactical control.

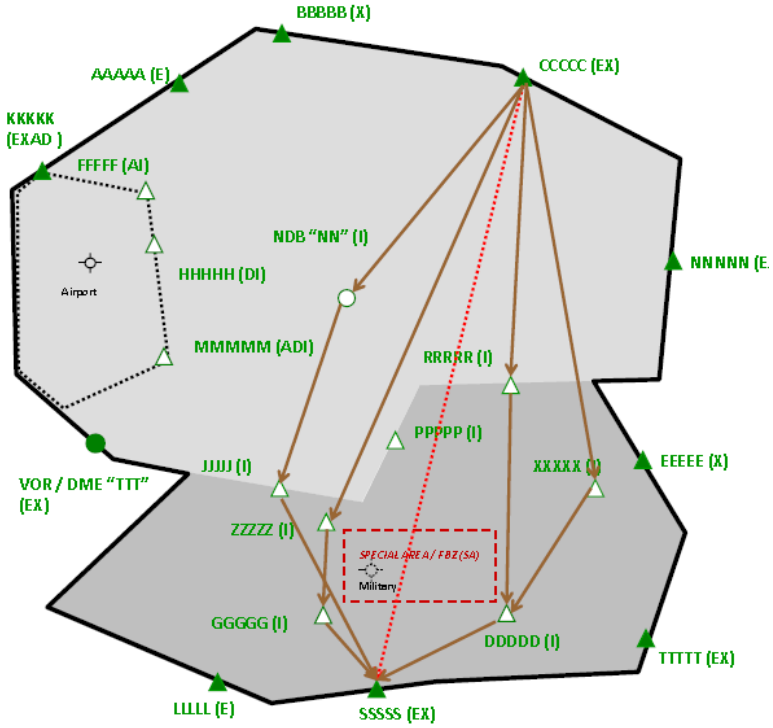
TMA: Terminal Manoeuvring Area

WebTAG: Department of Transport's web-based Transport Analysis Guidance; provides information on the role of transport modelling and appraisal, and templates for analysis (e.g. for Greenhouse gas emissions, and noise).

9. Appendix A: FBZs & NPZs explained

9.1 Flight plan Buffer Zones

A Flight plan Buffer Zones (FBZ) is a flight planning tool (always associated with SUA) used to provide a flight planning buffer around SUA.



A Flight-plan Buffer zone (FBZ) is an area in which flight plans will be rejected if the flight would enter the FBZ. They are usually used to ensure adequate flight plan trajectory separation from active military Danger Areas or other SUA. The example above shows the desired direct route (dotted red line from CCCCC to SSSSS) would be rejected due to the rectangular FBZ. This can be avoided by flight planning via the intermediate points (e.g. DDDDD or ZZZZZ+GGGGG).

9.2 No Planning Zones

An NPZ is a tool to restrict flight plans to prevent undesirable traffic flows.

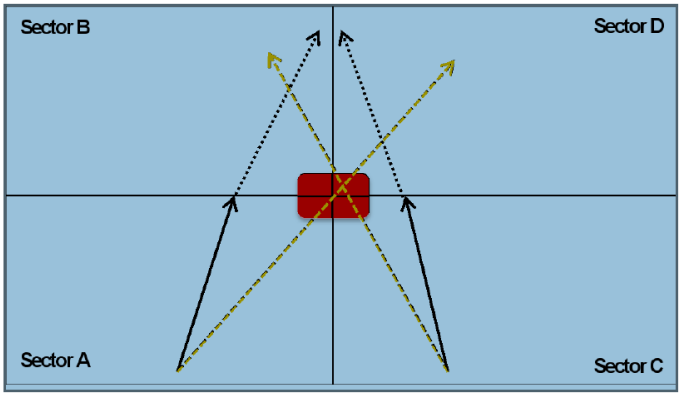
The guidelines below are set out within Para 4.5.5 of the Eurocontrol NM Flight Planning Requirements - Guidelines issued Dec 2018:

- When and where required to prevent inappropriate flight trajectory airspace crossings or to properly manage ATC operationally sensitive areas inside or across relevant FRA area/s establishment of No Planning Zone/s (NPZ) might be considered in accordance with provisions in ERNIP Part 1, 6.9.1.
- Within the airspace volume representing such zone the planning of flight trajectory is either not permitted or allowed under certain specified conditions. In order to assist the airspace users in the presentation of the intended flight operation, the flight planning limitation/s shall be defined in the Route Availability Document (RAD).
- Airspace users can avoid such zone by flight planning via appropriate significant points around it or in accordance with allowed conditions.
- Such a zone is named "No Planning Zone" (NPZ) and shall be published in accordance with provisions in ERNIP Part 1, Annex 4.

Case 1: Separation provision during transfer of control (Free Route Airspace)

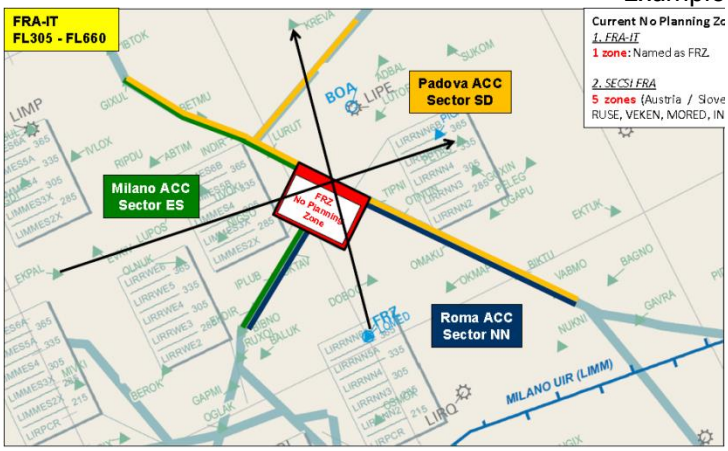
Occasions where two flights are transferred by two different upstream control sectors to two different downstream control sectors is difficult to manage. As such alignment of sector boundaries has to be avoided by coordinated airspace design.

If a coordinated airspace design approach is difficult or not practical and in order to manage such ATC operationally sensitive areas, limiting flight planning through a small critical part of the airspace around the sector boundaries (red shaded zone) has to be considered.

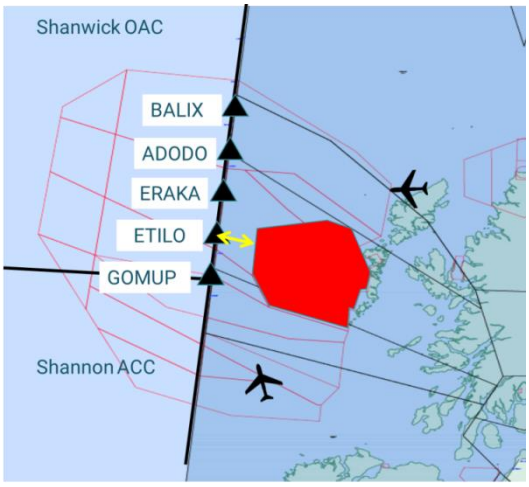


A **No Planning Zone (NPZ)** is the airspace of defined dimensions within which the planning of flight trajectory is either not permitted or only allowed under certain specified conditions. Airspace users can avoid such zone/s by planning via appropriate significant points around the zone/s or in accordance with allowed conditions.

Example



Case 2: NPZ used to prevent undesirable interaction around Oceanic interfaces



NPZs can be used to prevent undesirable interaction around Oceanic interfaces. The example below illustrates how an NPZ to the West of D701 may be used to prevent aircraft routing too close the Oceanic boundary whilst D701 is active (which could create crossing interactions with no space to resolve conflictions).