

FUTURE | AIRSPACE | STRATEGY

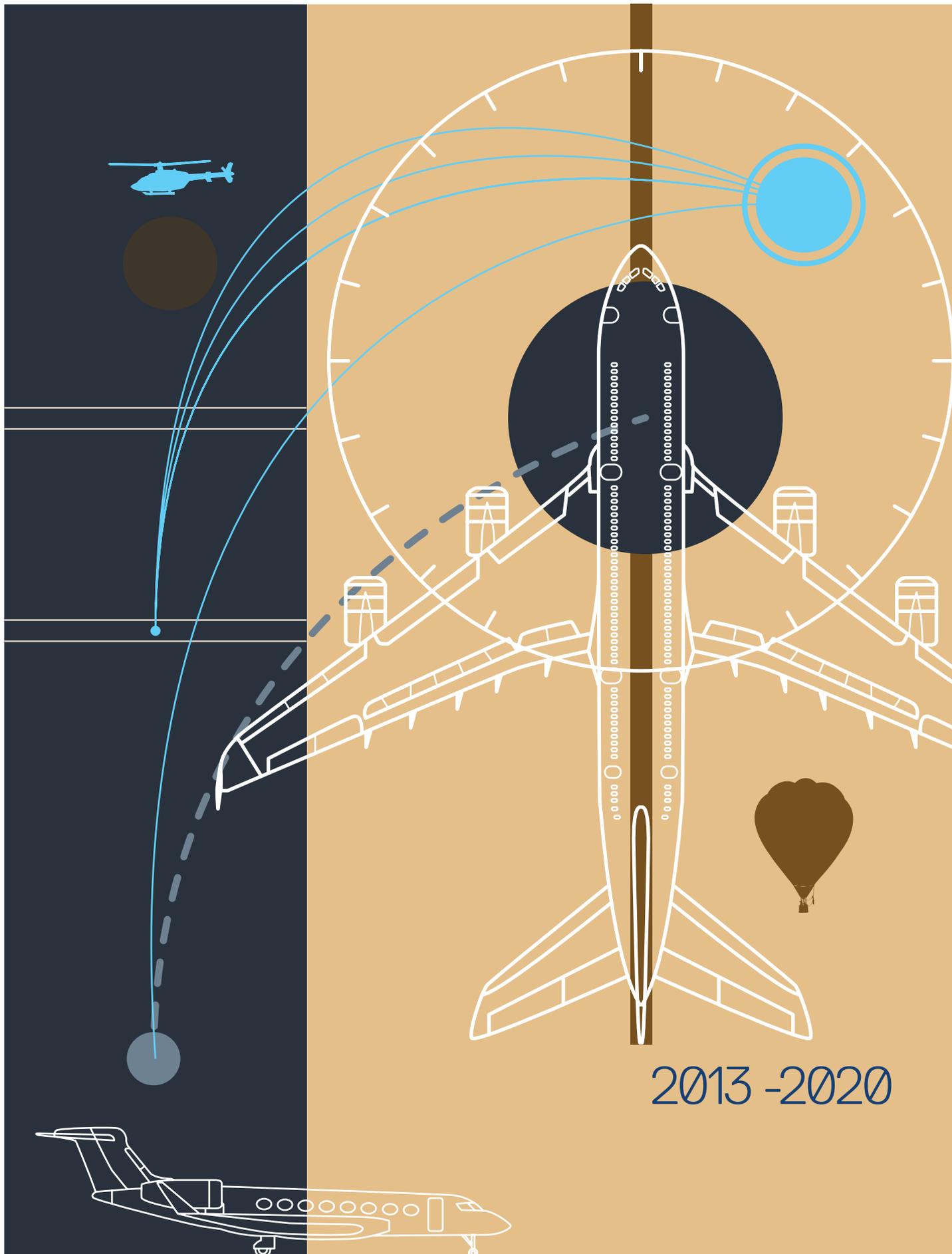
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Iteration Three, Version 1.2  
December 2012

# Future Airspace Strategy Deployment Plan

Level one

Modernising airspace across the UK and UK and Ireland FAB



2013 -2020

**The Aviation Sector is a critical part of the UK's and Ireland's transport infrastructure.**

**Sustainable growth in aviation is dependent on the modernisation of our airspace system to tackle key areas of inefficiency and generate significant benefits for passengers, industry and the environment.**



# 1. Executive Summary

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## Context

Much of the debate about a shortage in capacity for aviation in the UK centers on runway infrastructure. However, airspace is also a major factor because of its effect on the overall efficiency of the aviation sector and the environment.

As a small country with huge demand for aviation, UK airspace is a very scarce resource. Our airspace system was designed over 40 years ago. It has not been comprehensively updated since and is still based around decades old technology.

The Transport Select Committee held an enquiry into airspace in 2008. Evidence from industry directed the CAA to draw up a Future Airspace Strategy (FAS) to modernise the UK airspace system, including the en-route airspace managed collectively by the UK and Ireland as a Functional Airspace Block (FAB).

## Domestic, European and Global Alignment

The modernisation of our airspace system strongly supports the UK Government's aviation policy objective – to maintain the country's international hub connectivity. In the near term, FAS initiatives can increase the efficiency of existing runway capacity. Over the longer term (beyond 2020) modernisation of the airspace will enhance the aviation sector's ability to adapt to future airport developments.

Airspace in the UK and UK/Ireland FAB is not being developed in isolation. The Single European Sky (SES) initiative was established to tackle inefficient, costly and fragmented airspace structures across Europe. The FAS Deployment Plan contributes to the implementation of SES objectives. In particular, by coordinating local deployment of solutions developed in the technological pillar – SESAR. On the global stage FAS is aligned to the ICAO Aviation System Block Upgrades (ASBUs) and US 'Next Gen' Programme.

## The FAS Deployment Plan

The FAS Deployment Plan considers the first phase of FAS implementation from 2013 to 2020. The plan has been developed in a truly collaborative way, with aircraft operators, airports, ANSPs, the military and regulators all represented on the FAS Industry Implementation Group (FASIIG).

The deployment plan is a compilation of confirmed and proposed investments drawn from the programme plans and strategic ambitions of the key organisations involved. FAS is therefore completely dependent on industry to drive implementation. Common lines of action are required from all stakeholder groups and the regulator if the benefits are to be achieved.

There are no silver bullets in the deployment plan. Multiple initiatives focus on improving the way air traffic is managed and moves around the network, including:

- Implementing a fundamentally more efficient route network in the busy terminal environment.
- Removing fixed structures in the upper airspace enabling more direct routes.
- Streaming traffic through speed control and improving arrival punctuality to manage queuing and reduce stack holding.
- Re-designing departure procedures to allow aircraft to climb continuously and increase runway throughput.
- Connecting airports electronically into the network to share accurate information and better sequence departures and arrivals.

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## Benefits

The first phase of FAS implementation is expected to deliver significant benefits for the aviation industry, consumers and the wider community.

For aircraft operators the airspace system is a key determinant of costs, punctuality and environmental efficiency. For airports it impacts runway throughput, resilience and ground delays. Airspace modernisation also provides opportunities to continually enhance safety. Once implemented the first phase of FAS implementation is expected to:

- Generate airspace capacity to accommodate forecast demand out to 2025.
- Save over 160,000 tonnes of fuel per year (with an estimate net present value to operators of £907m to £1.17bn out to 2030).
- Save over 1.4m minutes of operator's time per year, reducing maintenance and crew costs (with an estimate net present value to operators of £338m – £441m out to 2030).
- Save over 1.1m minutes of passenger delay per year (valued as the opportunity cost of passenger's time at £446m – £588m out to 2030).
- Save over 500,000 tonnes of aviation CO2 emissions per year (valued as the forecast price of carbon at £188m to £241m out to 2030).
- Enhance safety by reducing controller and pilot workload and designing out risk factors.

Although the benefits of modernisation are largely concentrated on commercial air transport the need to ensure access to sufficiently sized and sited airspace for other users, in particular the Military and General Aviation (GA) community, is an important factor in the way the plans will be progressed.

## Implementation Challenges

The FAS Deployment Plan aims to provide the aviation sector with a framework to tackle the challenges of implementing major changes to the airspace system in a joined up way, concentrating on:

*Prioritisation:* Scarce resources, complex programmes and a mix of vested interests mean prioritising where and when to implement changes will be a major challenge during the deployment phase.

*Performance:* Drawing a clear line of sight between key FAS initiatives and expected performance improvements is important to ensure implementation targets are stretching but achievable and the emphasis on cost reduction is balanced with investment capital to ensure deployment remains performance driven across regulatory control periods.

*People:* A major effort is needed across industry to ensure operational personnel are sufficiently engaged, trained and certified as changes are introduced. FAS deployment must also tackle the change management and social dialogue needed to evolve industry cultures and the passenger's expectations.

## High Priority Risks

A number of high priority risks have been identified during the production of the plan. These risks are founded on the experience of previous airspace re-design and operational improvement initiatives. They will form the core of the risk management activities progressed during the deployment phase.

The redistribution of the impact of aircraft noise, mixed fleet equipage levels and the uncertainty associated with regulatory change processes are the source of significant risks to the successful implementation of the FAS Deployment Plan.

There is also a risk that deployment is deterred or de-scoped in some areas due to the a lack of clearly identifiable benefits for some stakeholder groups or the commercial incentive to minimise any short term costs associated with transitioning away from today's

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## 2013 priorities by stakeholder group

The deployment plan identifies a number of areas to be progressed as a priority in 2013 because they have the potential to generate near term improvements or lay the foundation for future changes:

### *CAA priorities for 2013:*

- Consult on a mandate for the implementation of Performance Based Navigation (PBN) in certain volumes of UK controlled airspace.
- Assess the incentives that drive industry behaviours around scheduling and block times to generate options for improved predictability.
- Refine the business case analysis that underpins FAS deployment concentrating on expected costs and benefits by stakeholder group and the alignment to the SES Performance Scheme KPIs.

### *ANSP priorities for 2013:*

- Develop the network level terminal airspace re-designs for the South East of England (LAMP) and the Northern Terminal Control Area (NTCA).
- Embed Arrival Management capabilities into en-route air traffic control to stream traffic efficiently into the terminal environment.
- Enhance the performance of upper airspace sectors as part of the UK / Ireland FAB.

### *Aircraft operator priorities for 2013:*

- Support the ANSP to develop advanced procedures as part of the network level terminal airspace re-designs.
- Contribute to the development of the CAA's impact assessment for a PBN mandate by sharing information about the likely costs, benefits and risks of different implementation scenarios.
- Equip fleets and gain operational approvals for the required navigation and communication capabilities.

### *Airport priorities for 2013:*

- Define their requirements to re-design or replicate low level arrival and departure procedures for PBN to ensure they link efficiently into network level terminal airspace designs and realise the benefits of PBN implementation in the timescales envisaged by operators.
- Strengthen the systems and processes used to share planned time of departure information electronically with the network and support the development of Arrival Management capabilities across the UK/ Ireland FAB.
- At capacity constrained airports, consider the timescales for implementation of Collaborative Decision Making arrangements to improve departure sequencing, manage taxi times and reduce queuing at holding points on the runway.

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FAS Deployment Plan

↓  
December 2012

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Iteration 3, v1.2

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## 2. Introduction

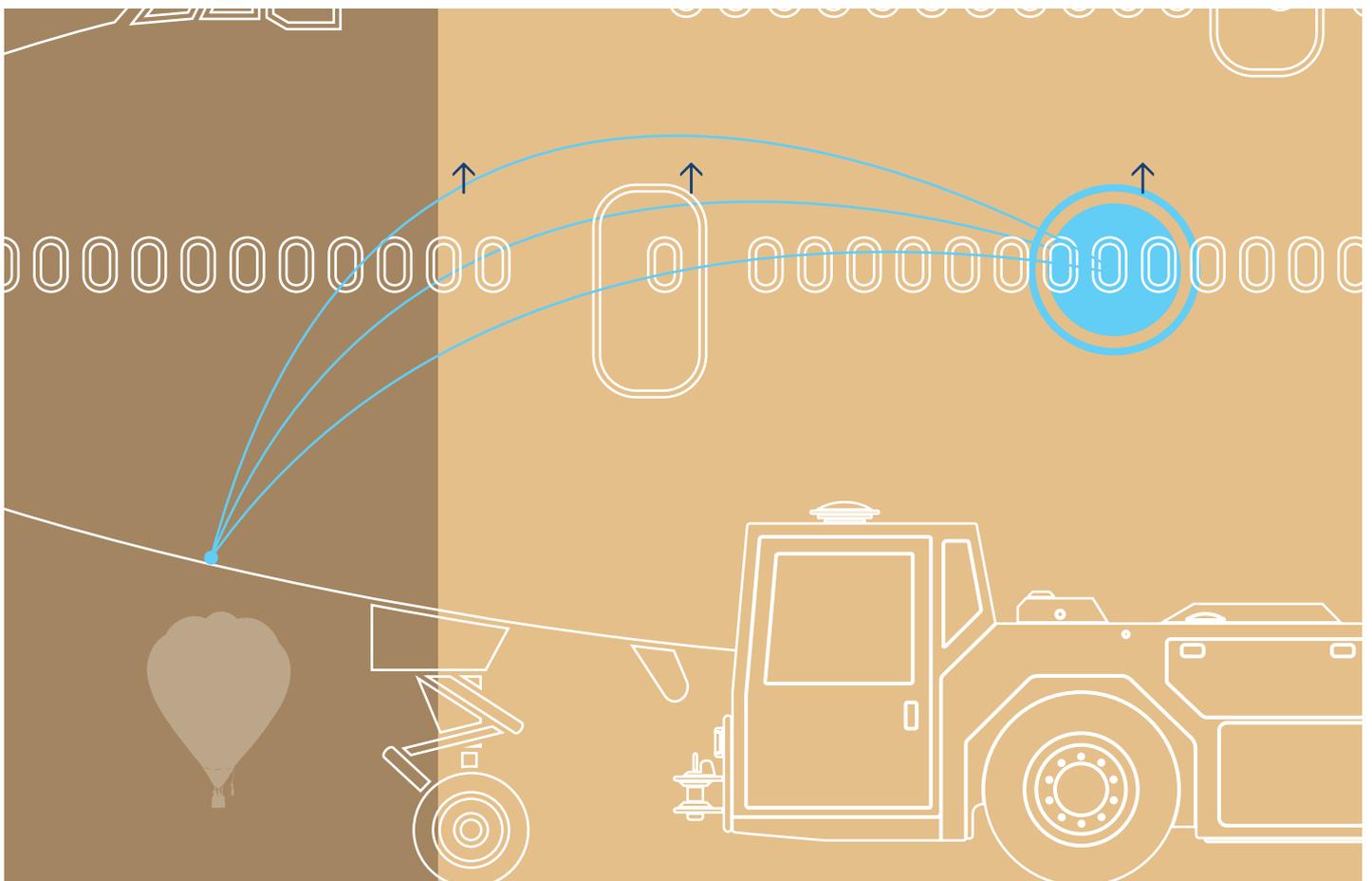
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01. Welcome to the third iteration of the FAS Deployment Plan to modernise the airspace system across the UK and UK Ireland Functional Airspace Block (FAB). The plan has been produced by the FAS Industry Implementation Group (FASIIG) - a consortium of aircraft operators, airports ANSPs, the CAA, IAA and MoD.

The group was formed in 2011 following publication of the CAA's Future Airspace Strategy (FAS)<sup>1</sup> to link major airspace programmes and industry investment plans. The deployment plan describes the common lines of action required of each stakeholder group to implement the first phase of FAS from 2013 to 2020.

0.2 This document represents level one of the deployment plan. It describes the major cross-industry FAS initiatives and the operational improvements they are expected to make, along with the outputs required of different stakeholder groups and the time windows for deployment.

As implementation progresses the deployment plan will become a living document underpinned by the programme plans for each initiative (level 2) and detailed delivery schedules (level 3).



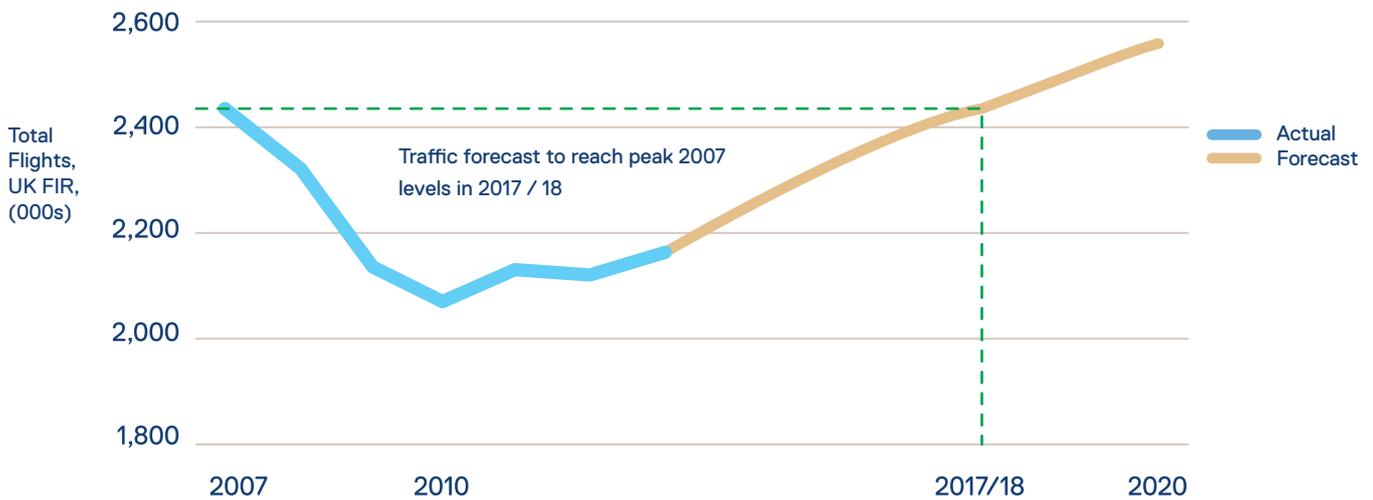
### Sustainable growth in aviation is dependent on the modernisation of the airspace system

03. The aviation sector is a core part of the UK and Ireland’s transport infrastructure, carrying over 250 million passengers and 2.5 million tonnes of freight every year: it incorporates commercial air transport, military activity and flying for private business, sports and leisure.

Aviation is dependent on the airspace system; which covers the airspace structures, the routes aircraft fly and the procedures used by ANSPs and airports to manage the flow of traffic. The system is essential to modern aviation and should be considered a national infrastructure asset similar to the road and rail networks.

04. The basics of our airspace system were developed over forty years ago. Since then aviation has undergone huge changes, including a hundred fold increase in demand. Modernisation of the system has now become critical to ensure sustainable growth as demand continues to increase and shift in focus – for example to encompass more flights to emerging markets.

↓ Chart 1: UK Flights, Actual and Forecast, 2007 - 2020



*Traffic levels in the UK dropped significantly from 2007 to 2010. The return of growth has been slowed by the weak recovery from recession across the Eurozone. In the medium term, out to 2020, annual average traffic growth is expected to remain at c.2%<sup>2</sup>. At this rate UK flights are only expected to exceed their 2007 peak in 2017/18, and possibly later.*

1. www.CAA.co.uk/FAS

2. Based on NATS Traffic Forecasts from January 2012 - in the near term (2013 and 2014) UK flights are expected to grow by c.1% per year.

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## FAS concentrates on tackling the key areas of inefficiency in today's airspace system

05. If FAS initiatives are not deployed successfully inefficiencies in today's airspace system will intensify over time, creating bottle necks, imposing costs and restricting growth.

The deployment of FAS initiatives also provides us with the opportunity to consider safety improvements which may be made during the re-design. The first phase of FAS implementation is focused on three of the main sources of inefficiency:

1

### 1. Complex and congested terminal airspace:

characterised by frequent route interactions that require high levels of controller intervention to manage. The current arrangements restrict aircraft's ability to climb and descend efficiently and the ability of airports to maximise the efficiency of their runways. The issues are most acute in the terminal airspace above the South East of England.

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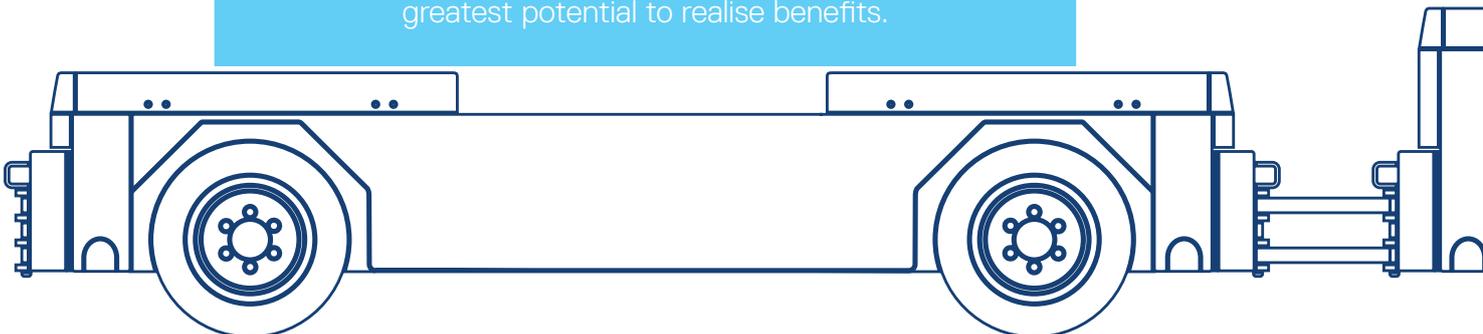
### 2. Regular Arrival Delays:

the product of limited runway capacity and an over-delivery of traffic to the terminal (that is often planned into schedules and exacerbated by poor arrival punctuality). Arrival delays are typically managed through stack holding or tactical vectoring that burns extra fuel and uses valuable airspace capacity.

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### 3. Under-utilisation of Performance Based Navigation (PBN):

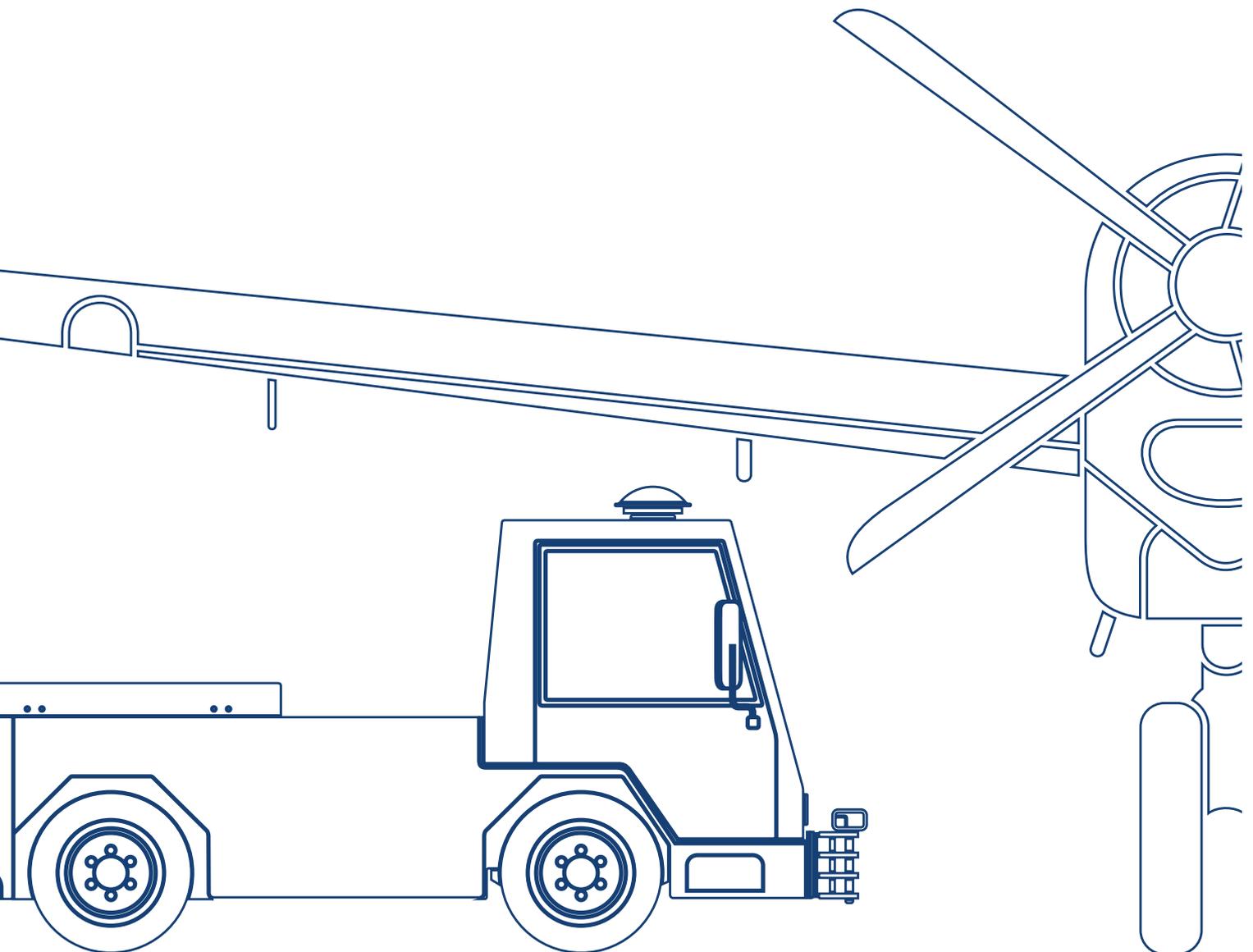
The advanced navigational capability of many aircraft is significantly under used in today's airspace, especially in the terminal environment and at low altitudes around key airports, where much of the fleet is already equipped and there is the greatest potential to realise benefits.



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06. The en-route airspace managed collectively by the UK and Ireland as a Functional Airspace Block (FAB) is also within the scope of FAS. The UK and Ireland FAB was established in 2009 and is already benefiting operators. Further developments in the FAB are planned to help tackle the issues in the terminal – most importantly through arrival management – the streaming of traffic through speed control to manage queuing and absorb delays.

07. On the ground, the aircraft turnaround phase is a major determinant of runway efficiency, particularly for departures, and forms a core strand of the deployment plan. Joint civil / military cooperation in Flexible Use Airspace (FUA) reserved for hazardous activities is subject to FAS modernisation plans too.



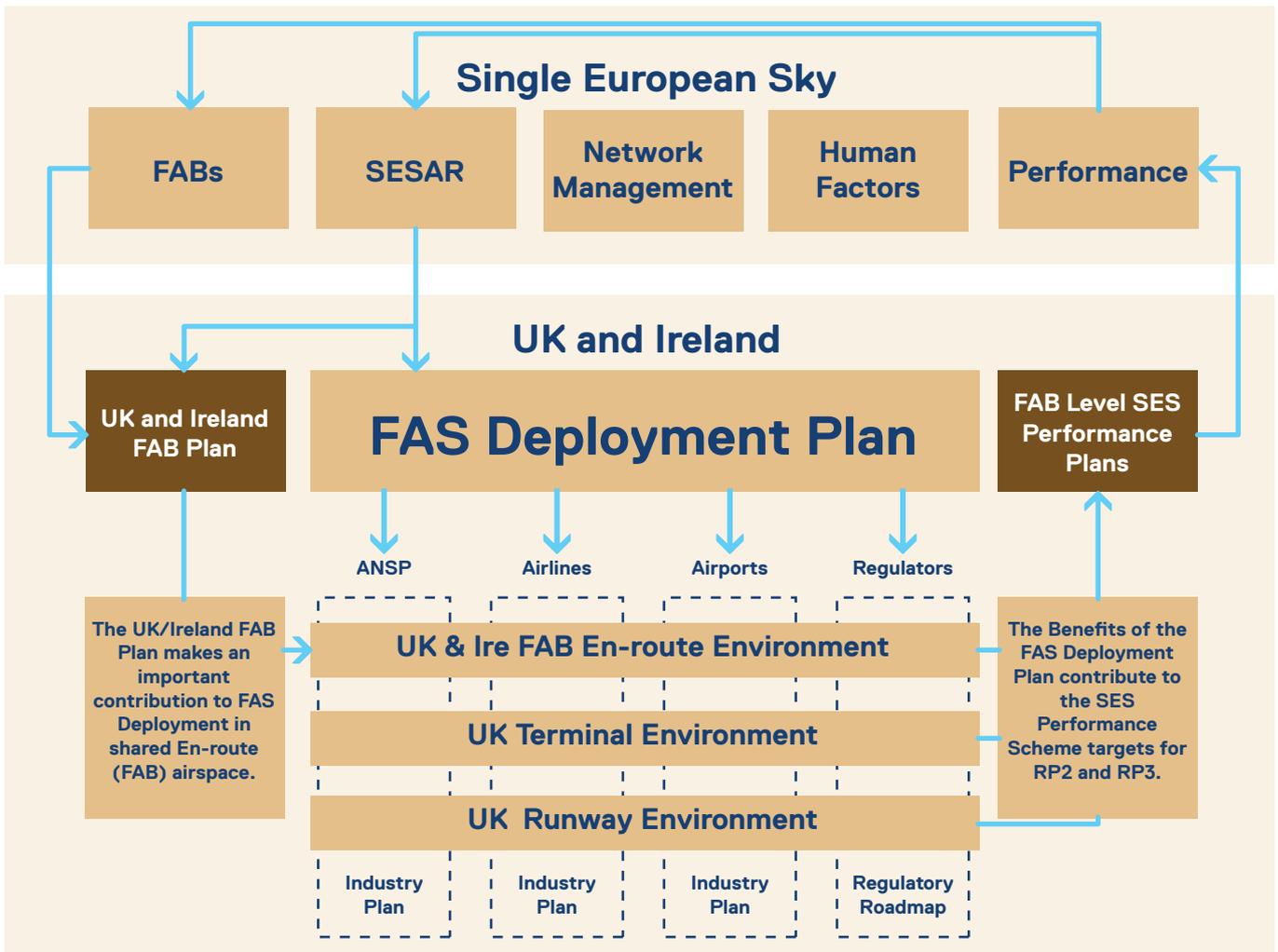
## European alignment and domestic policy and regulation

08. Changes in the UK and UK/Ireland FAB are not being progressed in isolation. Throughout Europe there is a move to simplify and harmonise the airspace system through the Single European Sky (SES) initiative.<sup>3</sup> One of the objectives of FAS is to contribute to the implementation of SES objectives in the UK and UK/Ireland FAB. FAS is also closely aligned to Step 1 of SESAR deployment and will become a key mechanism for tailoring SESAR solutions to the local network.<sup>4</sup>

The benefits generated through FAS will contribute to achieving European wide performance improvement targets set by the Commission.

Chart 2 illustrates the Relationship between the FAS Deployment Plan and the European wide initiatives to modernise airspace.

↓ Chart 2: Relationship between the FAS, FAB and SES Initiatives



3. [www.eurocontrol.int/content/single-sky-europe](http://www.eurocontrol.int/content/single-sky-europe)  
4. [www.sesarju.eu](http://www.sesarju.eu)

09. In North America, the 'Next Gen' Programme is driving similar airspace modernisation plans.<sup>5</sup> ICAO's Aviation System Block Upgrades (ASBUs) are harmonising developments globally.<sup>6</sup> The FAS Deployment Plan is commensurate with the objectives of both.

10. The modernisation of our airspace system strongly supports the UK Government's aviation policy objective – to maintain the country's international hub connectivity. It is assumed that the changes proposed in the deployment plan will be implemented in advance of any significant airport expansion in the South East of England. In the near term, FAS will enable airports to improve the use of their existing runway capacity. Over the longer term (to 2020 and beyond) greater capacity, flexibility and efficiency in the airspace will enhance the Aviation Sector's ability to adapt to future airport developments.

11. The CAA set the initial direction for the development of FAS. As the strategy moves into implementation it will continue to play a central role, producing the policies and regulation needed to ensure the changes are not only timely and cost effective, but balanced, with respect to all airspace users and the impact to those on the ground.



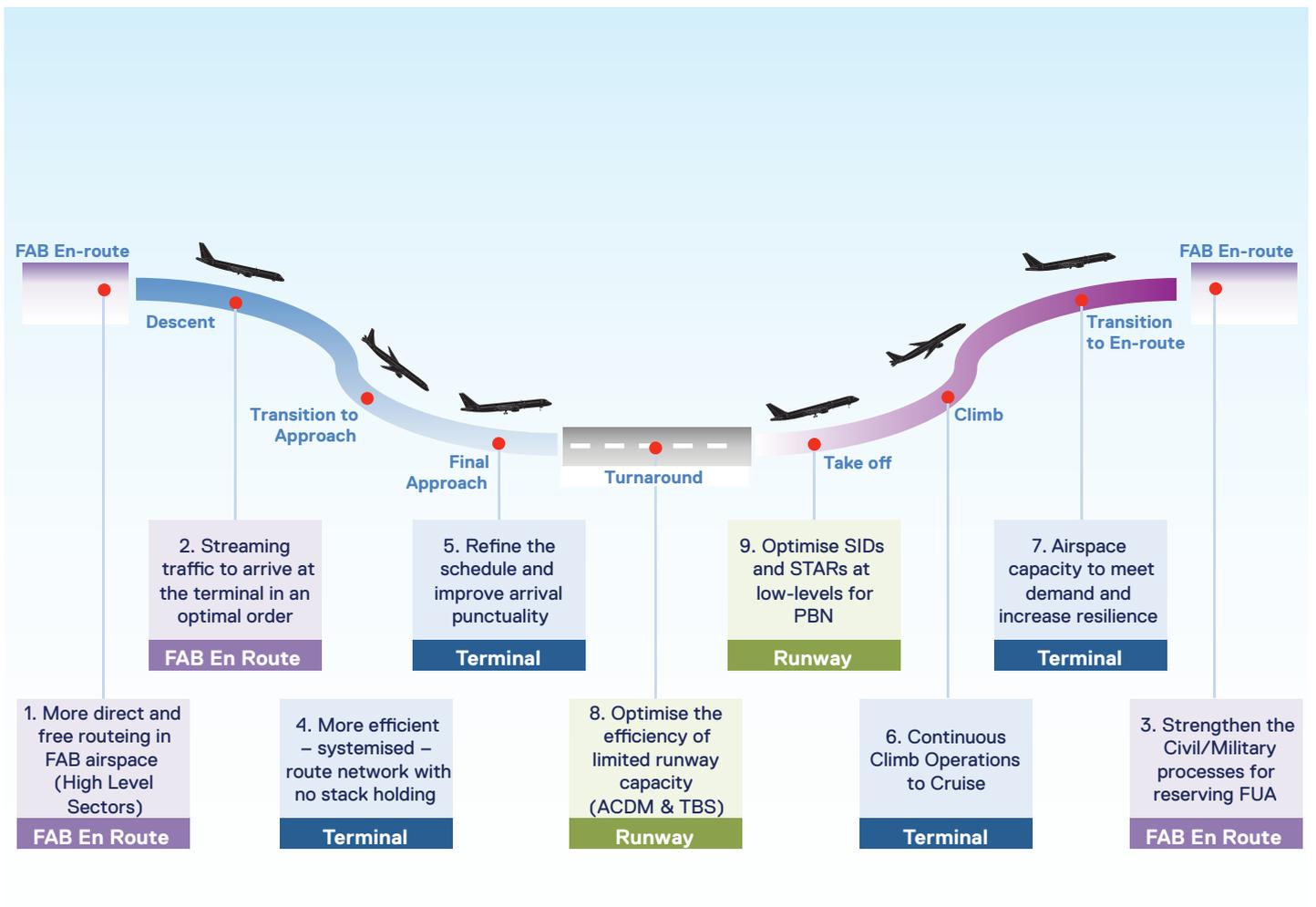
5. [www.faa.gov/nextgen](http://www.faa.gov/nextgen)

6. <http://www.icao.int/Meetings/anconf12/ASBUs/Forms/AllItems.aspx>

### 3. Improvements and Benefits

12. Essentially, FAS aims to improve the way traffic is managed and moves around the network. The improvements affect every phase of flight across the en-route, terminal and runway environments. The chart below summarises nine of the key operational improvements FAS aims to deliver along a typical flight.

↓ Chart 3: FAS operational improvements by phase of flight



13. Airspace improvements will generate significant benefits for the aviation industry, the passengers it serves and the wider community. Benefits are tracked from 2013 and projected out to 2030. The net present value is quoted in 2011 prices for direct financial benefits (fuel and cost savings) and broader societal benefits (CO<sub>2</sub> and passenger time savings). In summary the first phase of FAS implementation is expected to deliver:

→ **Airspace capacity:** to meet forecast demand out to 2025 – a key enabler for economic growth.

→ **Fuel savings:** of over 160,000 tonnes per year from aircraft flying more efficient vertical profiles, more direct routes and experiencing fewer delays – with an estimated NPV to operators of £907m to £1.17bn.

→ **Time savings:** of over 1.4 million minutes per year reducing maintenance and crew charges – with an estimated NPV to operators of £338m to £441m.

→ **CO<sub>2</sub> savings:** of over 500,000 tonnes per year associated with the reduction in fuel burn – valued as the forecast price of carbon at £188m to £241m.

→ **Passenger time savings:** of over 1.4 million minutes per year – valued as the opportunity cost of passengers' time at £446m to £588m.

14. Although the benefits of modernisation are largely concentrated on commercial air transport, the need to ensure access to sufficiently sized and sited airspace for other users, in particular the Military and General Aviation (GA) community is an important factor in the way the plans are progressed. For example, adjusting the vertical profiles of commercial departures creates greater potential to provide GA users with access to new volumes of lower-level airspace.

15. The cost efficiency of air navigation services is influenced by a range of factors, many of which fall outside the scope of FAS. However, the changes described in the plan represent the airspace strands of a broader evolution in air traffic management that includes greater automation and technical convergence across European ANSPs (driven through SESAR and FABs respectively) which is expected to generate significant cost efficiencies.

## Improvements in the en-route FAB environment

16. The following three tables provide more detail about the improvements FAS aims to deliver, the time windows for deployment and a further breakdown of the benefits estimates.

17. The deployment plan considers the en-route environment across the entire UK and Ireland FAB. Airspace developments will be delivered through the UK/Ireland FAB Plan.

Improvement	Time Window for Deployment	NPV of estimated benefits out to 2030 (2011 prices)
<b>Implementing high-level ‘super sectors’</b> across the UK/Ireland FAB to facilitate the removal of fixed airspace structures and create more direct and free route opportunities.	2015 – 2019	Fuel: £86m - £119m CO <sub>2</sub> : £18m - £24m  <b>Total: £104m - £143m</b>
<b>Developing a Queue Management capability within the UK/Ireland FAB</b> , using ATC support tools (AMAN) to absorb some arrival delays through speed control in the en-route sectors and stream traffic to arrive in the terminal in an efficient order for landing.	2013 – 2017	Fuel: £72m - £85m Time: £71m - £83m CO <sub>2</sub> : £14m - £17m Delay: £99m - £117m  <b>Total: £256m - £302m</b>
<b>Expanding the Queue Management capability across FAB boundaries</b> , to increase international co-operation (through a tool known as XMAN), and further the scope to absorb arrival delays and accurately stream traffic.	2013 – 2020	Fuel: £55m - £70m Time: £53m - £69m CO <sub>2</sub> : £10m - £14m Delay: £75m - £97m  <b>Total: £193m - £250m</b>
<b>Continuing to strengthen the Civil / Military processes for reserving ‘Special Use Airspace’</b> for hazardous activity to maximise the ability for airline flight planners to take advantage of more direct routes.	2013 – 2018	Fuel: £17m - £23m CO <sub>2</sub> : £3m - £5m  <b>Total: £20m - £28m</b>

↑ Table 1: FAS improvements in the en-route FAB environment

## Improvements in the terminal environment

18. The terminal environment – from the en-route airspace down to c.4000ft – is the cornerstone of the FAS Deployment Plan and offers the greatest potential to make improvements. Airspace developments will be led by the ANSP, but airports, operators and the regulator each have important roles to play.

Improvement	Time Window for Deployment	NPV of estimated benefits out to 2030 (2011 prices)
<b>Implementing a more efficient route network, designed to PBN standards</b> to systemise arrival and departure procedures, reduce track miles and free up valuable airspace capacity.	2015 – 2019	Fuel: £499m - £622m CO <sub>2</sub> : £107m - £133m  <b>Total: £606m - £755m</b>
<b>Refining the schedule, improving arrival punctuality and removing stack holding</b> in normal operations (supported by AMAN in the en-route) to reduce arrival delays, enable continuous descents and free up further airspace capacity. High runway utilisation rates are maintained through implementation of linear holds.	2014 - 2018	Fuel: £55m - £81m Time: £53m - £79m CO <sub>2</sub> : £11m - £16m Delay: £75m - £111m  <b>Total: £195m - £287m</b>
<b>Enabling more continuous climbs to the cruise</b> to capitalise on the available airspace capacity .	2015 – 2019	Fuel: £15m - £47m Time: £14m - £44m CO <sub>2</sub> : £3m - £8m Delay: £21m - £67m  <b>Total: £53m – £168m</b>

↑ Table 2: FAS improvements in the terminal environment



## Improvements in the runway environment

19. The runway environment – from c.4000ft down to the ground – includes the low-level airspace reserved for take-off and landing, where the impact of aviation to those on the ground takes precedence and airports are responsible for managing the effects of any changes on their local communities.

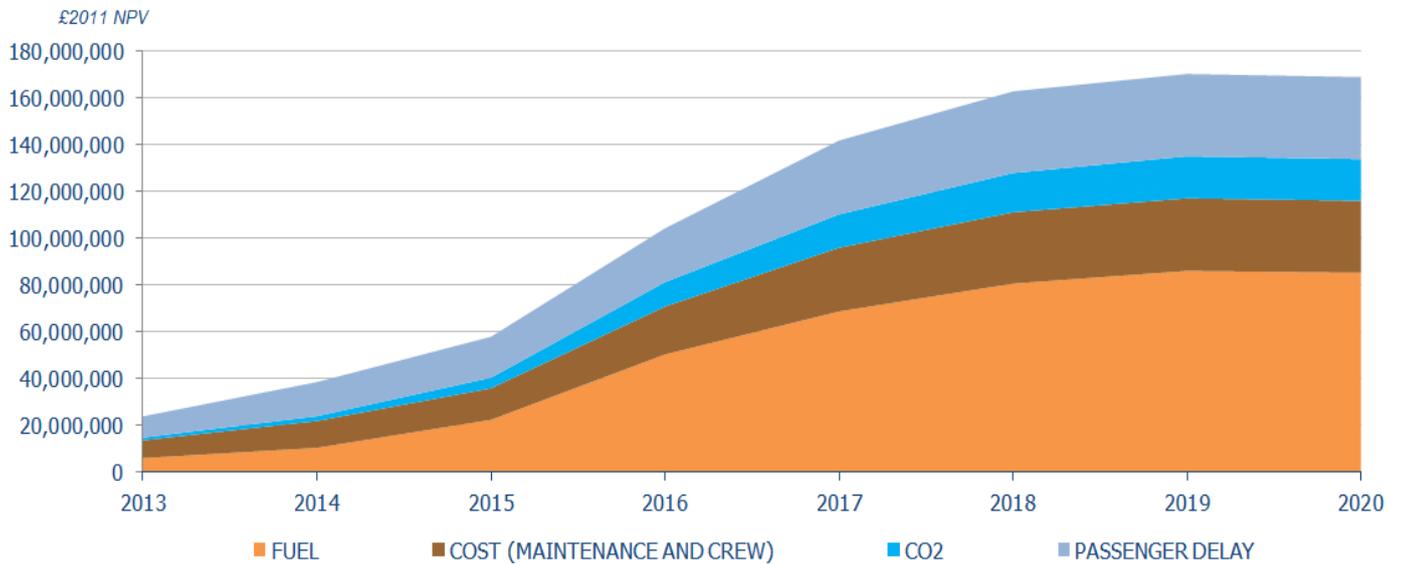
The effectiveness of aircraft turnaround processes is also a focus of FAS improvements in the runway environment.

Improvement	Time Window for Deployment	NPV of estimated benefits out to 2030 (2011 prices)
<b>Replicating or fully re-designing airports' SIDs and arrival procedures to PBN standards</b> , to optimise their environmental (noise) and operational performance and connect them to the PBN terminal network.	2013 – 2017	<b>Critical enabler for Terminal Re-design benefits</b>
<b>Integrating airports electronically into the network</b> to share departure planning information (DPI), generating an up to date picture of outbound traffic flows and runway demand. DPI is used by network managers and controllers to better manage departures through busy sectors and stream arrivals.	2013 – 2015	<b>Critical enabler for Queue Management benefits</b>
<b>Implementing Airport Collaborative Decision Making (A-CDM)</b> at capacity constrained airports to improve the turnaround process, reduce taxi times and maximise runway efficiency.	2013 – 2018	Fuel: £62m - £75m Time: £102m - 122m CO <sub>2</sub> : £12m - £15m Delay: £113m - £135m  <b>Total: £289m - £347m</b>
<b>Introducing Time Based Separation (TBS)</b> , where appropriate, to enable closer approach spacing in strong wind conditions, increasing runway resilience and reducing weather related delays.	2016 - 2020	Fuel: £32m - £45m Time: £31m - £44m CO <sub>2</sub> : £7m - £10m Delay: £44m - £62m  <b>Total: £114m - £161m</b>

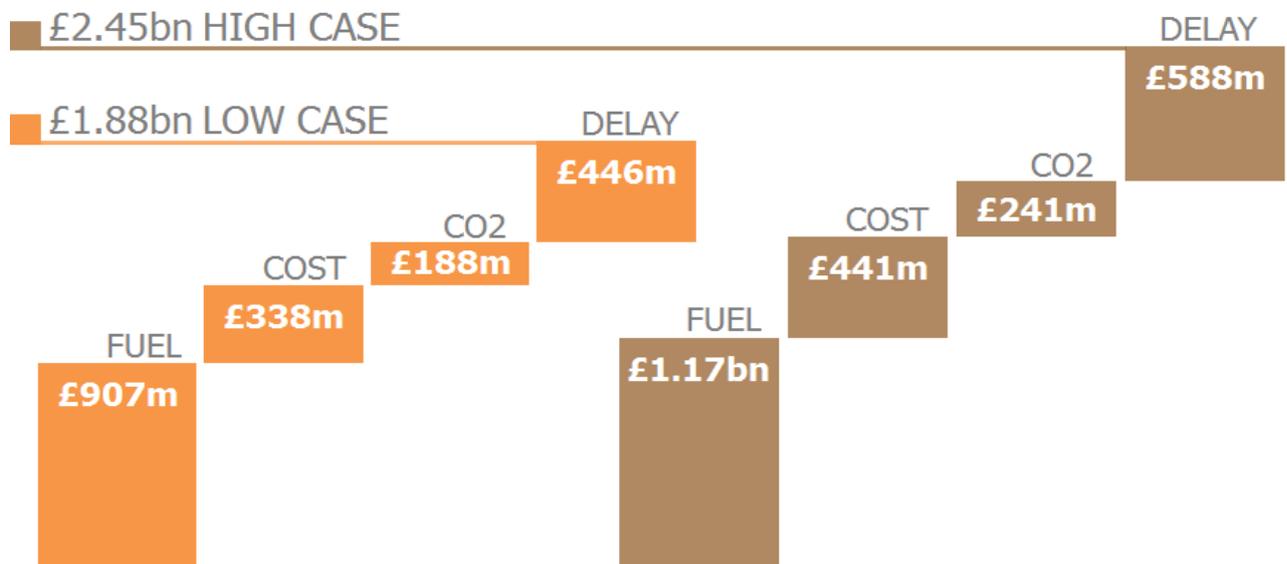
↑ Table 3: FAS improvements in the runway environment

20. The chart below summarises the expected growth in annual estimated benefits from 2013 to 2020 in 2011 prices.

↓ Chart 3: Annual growth in total estimated value of FAS benefits accruing from 2013 to 2020, in 2011 prices



↓ Chart 4: Total estimated value of FAS benefits accruing from 2013 to 2030 by type, in 2011 prices



## Benefits to airports

21. The benefits of FAS initiatives are quantified at a network level. Benefits for individual airports and operators will vary depending on the nature of their

operation. Tables 4 and 5 describe the typical benefits for airports and aircraft operators along with the key FAS initiatives that enable them and relevant sections of the plan.

Airport benefits	Initiatives	Section
<b>Increased runway throughput without infrastructure investment</b>	RNAV1 inbound routes reduce controller workload releasing capacity to concentrate on aircraft speeds to increase the efficiency of runway operations.	Terminal Airspace Re-design (A1)
	Re-designed RNAV1 SIDs enable continuous climbs and reduce departure intervals when successive aircraft are established on diverging procedures.	PBN Implementation (C1)
<b>Greater airport punctuality and resilience</b>	More accurate scheduling and refined block times increase the predictability of arrivals.	Arrival Management & Airport Integration (B1)
	Electronically sharing departure planning information increases situational awareness and coordination across the airfield and the network.	
	Time-Based Separation maintains runway utilisation during high wind conditions.	Advanced ATC Tools (C2)
<b>Reduced taxi times &amp; queuing at holding points on the airfield</b>	Implementing Airport Collaborative Decision Making (A-CDM) at capacity constrained airports improves departure sequencing.	A-CDM and Departure Management (B2)
<b>More environmentally efficient departure routes</b>	Greater precision and closer spacing minimises the impact on operational performance of measures to manage the impact of aircraft noise at low altitudes.	Terminal Airspace Re-design (A1)
<b>Enhanced safety and resilience from the removal of non-precision approaches</b>	RNAV1 implementation enables removal of non-precision approaches through introduction of APVs.	PBN Implementation (C1)

↑ Table 4: Benefits to airports

## Benefits to aircraft operators

Operator Benefit	Initiatives	Section
<b>Reduced fuel burn through improved vertical and lateral performance</b>	Systemised RNAV1 route network in the terminal area reduces track miles.	Terminal Airspace Re-design (A1)
	RNAV1 SIDs and arrival routes enable more continuous climbs and descents procedures.	PBN Implementation (C1)
	Removal of fixed airspace structures enables more direct routes at efficient levels and speeds in the en-route phase.	En-route UK/Ire FAB airspace re-design (A2)
<b>Reduced fuel burn through fewer air-borne and ground delays</b>	Better arrival routeing and management reduces fuel burnt in stack holds and enables more continuous descents.	Arrival Management & Airport Integration (B1)
	Implementing Airport Collaborative Decision Making (A-CDM) at capacity constrained airports reduces taxi times and delays.	A-CDM and Departure Management (B2)
<b>Reduced maintenance and crew costs through fewer delays</b>	Better arrival routeing and management reduces time spent in stack holds.	Arrival Management & Airport Integration (B1)
	Implementing Airport Collaborative Decision Making (A-CDM) at capacity constrained airports improves departure sequencing.	
<b>Greater punctuality and resilience</b>	Streaming traffic in the en-route through speed controls increases arrival predictability and punctuality.	Arrival Management & Airport Integration (B1)
	More accurate scheduling and refined block times increase the predictability of arrivals.	
<b>Enhanced safety and resilience from the removal of non-precisions approaches</b>	RNAV1 implementation enables removal of all non-precision approaches through introduction of APVs.	PBN Implementation (C1)

↑ Table 5: Benefits to aircraft operators

## Estimating FAS Benefits



\* [www.eurocontrol.int/documents/standard-inputs-eurocontrol-cost-benefit-analyses](http://www.eurocontrol.int/documents/standard-inputs-eurocontrol-cost-benefit-analyses)  
[www.decc.gov.uk/en/content/cms/emissions/valuation/valuation.aspx](http://www.decc.gov.uk/en/content/cms/emissions/valuation/valuation.aspx)

## 4. Implementation Challenges and Risks

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### Implementation Challenges

22. The FAS Deployment Plan aims to provide the aviation sector with a framework to tackle the challenges of implementing major changes to the airspace system in a joined up way, concentrating on:

- **Prioritisation** – We can't implement everything at once. Spreading resources over too many initiatives will not maximise benefits.
- **Performance** – Clarity on targets, drivers and metrics is required to ensure implementation is truly performance driven.
- **People** – The impacts of implementation on operational personnel, industry cultures and passengers' expectations must be carefully managed.

23. *Prioritisation:* Scarce resources, complex programmes and a mix of vested interests mean prioritising where and when to implement changes will be a major challenge during the deployment phase. Prioritisation decisions must be clear and consistent, especially about trade-offs. Embedding FAS as part of a stable aviation policy framework will be a big help.

Integrating new solutions with the existing operation is complex. New systems, procedures and airspace re-designs must be sequenced to effectively realise benefits. The risk of 'initiative overload', must be carefully managed with all stakeholder groups. Biting off too much will compromise performance.

24. *Performance:* Drawing a clear line of sight between key FAS initiatives and expected performance improvements is important to ensure implementation targets are stretching but achievable. The emphasis on cost reduction must be balanced with investment capital to ensure modernisation remains performance driven across regulatory control periods.

25. *People:* A major effort is needed across industry and the regulator to ensure people are sufficiently engaged, trained and certified as FAS deployment progresses. Tailoring solutions to the local network environment will require significant engagement with pilots, controllers and ground staff.

The provision of training and certification must be robust and cost effective to ensure the required numbers of qualified resources are available. FAS deployment must also tackle the change management and social dialogue needed to evolve industry cultures and passengers' expectations.

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## High Priority Risks

26. Large scale investment in the airspace system has often been deterred by the up front costs, high risks and complex interdependencies. Small incremental improvements progressed instead tend to concentrate on narrow objectives at the expense of significant network wide benefits. The deployment plan aims to provide the catalyst to generate true cross-industry buy-in and commitment to implement network wide changes and manage the risks effectively.

27. A number of high priority risks have been identified during the production of the plan. These risks are founded on the experience of previous airspace re-design and operational improvement initiatives. They will form the core of the risk management activities progressed during the deployment phase.

28. Risks are assessed on a 1 (low) to 3 (high) scale against likelihood (L), severity (S) and proximity (P). Risks with a total score (T) of 7 to 9 are considered high priority and summarised below:

29. *The redistribution of noise impacts* risks deterring the re-design of SIDs and arrival procedures at low altitudes. If local consultative groups are effective in blocking proposals, sponsors risk being unwilling or unable to incur the costs associated with deploying the changes required to realise sufficient benefits from some FAS initiatives. (L2, S3, P3 = T8)

30. *Mixed equipage levels* risk preventing the implementation of optimal airspace designs. If conventional procedures are retained to support a minority of non-PBN compliant operators sponsors risk being unable to make the changes required to realise sufficient benefits from some FAS initiatives. (L3, S2, P2 = T7)

31. *Regulatory change processes* risk generating unacceptable levels of cost and risk for airspace change sponsors. Optimal changes risk not being pursued due to uncertainty around design criteria, consultation requirements and approval processes, extending implementation timescales and/or reducing benefits. (L2, S2, P3 = T7)

32. *The regulatory funding settlement for reference period two* of the SES Performance Scheme (2015 to 2019) is a critical dependency for the major NATS airspace initiatives that form the core of FAS plans. The necessary emphasis on cost reduction must be balanced with scope to invest in future performance improvements. (L2, S3, P2 = T7)

33. *Industry stakeholders have optimised their operations and culture for the established airspace system.* There is a risk that if FAS changes are accompanied by some short-term cost increases, as industry takes time to adapt, deployment will be deterred by the commercial incentive to maintain the performance of today's system. (L2, S2, P3 = T7)

34. *The pursuit of network level benefits* leads to the potential for a misalignment between investors and beneficiaries. A lack of sufficient local benefits for some stakeholder groups risks reducing their willingness to invest and the wide scale adoption of new capabilities with the potential to deliver significant network level benefits would be foregone. (L2, S2, P3 = T7)

35. *A lack of an appropriate methodology to provide safety assurance* and track safety improvements risks delaying implementation by adding cost and business risk. (L2, S3, P2 = T7)

36. *A lack of executive level sponsorship for FAS deployment across industry* risks the required investment and change management activity not being driven as a priority, extending implementation timescales and/or reducing benefits. (L2, S3, P2 = T7)

# 5. The FAS Deployment Framework

37. The improvements described in section two are considered at a network level. Benefits accruing in the en-route, terminal and runway environments can be assessed relatively independently from one another. Conversely the outputs required to generate improvements often apply across all areas of the network. Therefore the FAS Deployment Framework, which describes the outputs required of each stakeholder group, is arranged thematically.

38. The framework consists of three strands covering different sections of the plan that focus on:

- A. Optimising the Airspace Design;
- B. Synchronising Traffic and Managing Queues; and
- C. Safely Separating Aircraft flying more precise and flexible routes.

39. The sections of the plan covered under each strand of the framework are set out in chart 4. FASIIG has identified three high priority sections of the FAS deployment plan:

- A1. Terminal and airport airspace re-design
- B1. Arrival management & airport integration
- C1. Implementation of Performance Based Navigation

40. Implementation of these priorities must take precedence because of their importance in tackling key inefficiencies in the current airspace system, realising near term benefits and underpinning other changes envisaged in FAS and SESAR.

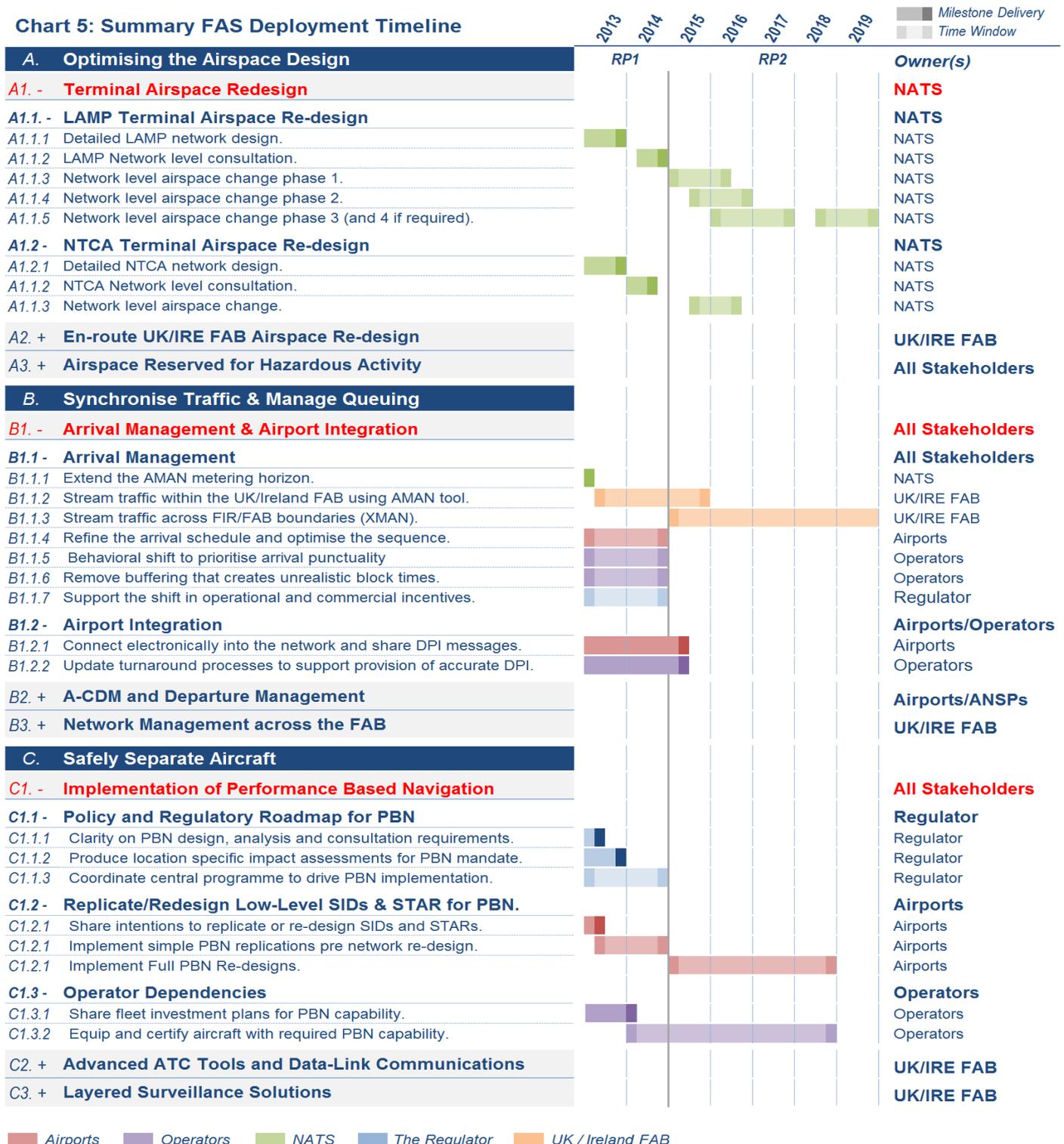
↓ Chart 4: The FAS Deployment Framework



↓ Chart 5 provides a summary of the FAS Deployment Plan gant chart with the three priority sections expanded.

The remainder of this document sets out all sections of the framework in more detail and describes the key dependencies on each stakeholder group.

**Chart 5: Summary FAS Deployment Timeline**



# A1. Terminal and Airport Airspace Re-design

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41. Re-designing the airspace is often a large and complex undertaking, incorporating the work required to produce network designs and detailed procedures, manage consultations with stakeholders to establish the preferred solutions, plan the migration path from the current design to the future design, implement the changes and coordinate the training of operational personnel.

42. The FAS Deployment Plan incorporates two major UK terminal airspace re-design programmes – the London Airspace Management Programme (LAMP) and the NTCA Programme – and the re-design of the low-level airspace around airports.

43. Optimisation of the airspace design aims to maximise the potential benefits of new ATM technologies and operating techniques introduced through other sections of the deployment plan such as Arrival Management (B1) and Performance Based Navigation (C1).

## **LAMP and NTCA Terminal Airspace Re-design (A1.1 and A1.2)**

44. LAMP is a once in a lifetime opportunity to modernise the London Terminal Control Region. The current airspace design does not effectively separate arrival and departure flows to individual airports onto dedicated routes. Interactions between traffic flows create the need for tactical interventions that interrupt continuous climbs and descents, increase controller and pilot workload and reduce airspace capacity. The LAMP programme considers a fundamental re-design of the terminal airspace at a network level, above c.4000ft (or the ceiling of noise preferential routes). The programme will improve the route network and remove stack holding in normal operations releasing valuable airspace capacity. More precise and systemised, arrival and departure procedures will be implemented to capitalise on the available airspace.

45. The LAMP re-design is expected to create airspace capacity to meet forecast demand out to 2025 with no additional air traffic control costs or delays. It will increase fuel and environmental efficiency by introducing more continuous climb and descent operations and reducing track miles. The reduction in route complexity and wide spread use of new technology will enhance safety.

46. In the Northern Terminal Control Area traffic levels are lower and there is more spare capacity. Nevertheless the re-design of the NTCA route network presents similar opportunities to generate fuel and environmental efficiencies through greater continuous climbs and descents and reduce complexity.

47. Continuous climb operations (CCOs) refer to the removal of the airspace constraints that result in the need for departing aircraft to recourse to level flight, thereby providing optimised climbs, dependent on the aircraft's configuration and performance capability. Currently many departures in the London terminal environment level off at between four and seven thousand feet in order to avoid incoming traffic. The LAMP and NTCA airspace re-designs aim to maximise the achievement of CCOs.

48. Continuous Descent Operations (CDOs) aim to reduce aircraft noise, fuel burn and emissions by improving the descent profile of aircraft into the terminal environment. A proportion of CDOs are achieved tactically in today's terminal design. It is envisaged this proportion will be increased and the benefits enhanced through the LAMP and NTCA designs, making sections of continuous descent longer and more frequent.

49. Arrival Management is a key enabler for continuous descents – ensuring aircraft are presented to the terminal in an optimal order and fly the shortest possible track distance at an optimal profile with minimal holding.



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## Terminal and Airport Airspace Re-design – Stakeholder Dependencies (A1.3)

50. (A1.3.1) *Replicating or Re-designing procedures for PBN.* At low altitudes – from c.4000ft down to the ground – the impact of aviation to those on the ground takes precedence and airports will be responsible for managing the effects of FAS deployment on their local communities. As a minimum airports in the LAMP and NTCA environments are required to replicate their existing arrival and departure routes at low altitudes to a PBN standard, increasing precision and integrating into the terminal network design that has been developed to the same advanced navigational standards. Some airports will choose to go beyond simple replications and re-design their SIDs and arrival procedures to realise the potential capacity and environmental benefits of PBN.

51. (A1.3.2) *Airline ‘Flyability’ Assurance* is an integral part of the procedure re-design process. Pilot and simulator time may be required to test new design concepts and route structures. The integration of airlines’ fuel uplift strategies is required to fully understand the costs and benefits of different scenarios that incorporate linear holding.

52. (A1.3.3) *A higher transition altitude* is required to provide the LAMP and NTCA network designs with sufficient airspace capacity and levelling options to de-conflict arrival and departure routes and enable systemised CCOs.

53. (A1.3.4) *Policy and Regulatory Dependency – PBN and Consultation.* Airspace re-design on the scale envisaged in LAMP and NTCA is unprecedented. It will require close collaboration across NATS, Airports, Operators and the Regulator. Strong Government support is also critical because deployment will involve a high degree of public consultation, particularly on the redistribution of noise impacts.

54. Successful airspace changes are dependent on the regulator establishing clear design, analysis and consultation requirements regarding the implementation of PBN routes. LAMP is the first airspace change in the UK to adopt PBN at scale. The design is based on an RNAV1 capability in the terminal environment from 2015/16.

55. The CAA will lead the programme to coordinate PBN implementation across the UK as part of FAS. Implementation will be informed by regulatory impact assessments in priority areas of the network, which aim to maximise the benefits of PBN, and guide the transition to full adoption while minimising the costs on non-equipped users (See C1. PBN Implementation below).

The table overleaf summarises the key dependencies by stakeholder group required to successfully re-design terminal and airport airspace:

↓ Ref.	↓ Dependency	↓ Timescales	↓ Owner
<b>A1.1 LAMP Terminal Airspace Re-design</b>			
A1.1.1	Produce the LAMP airspace / route network design (above c.4000ft).	2013	<b>NATS</b>
A1.1.2	Consult on the LAMP airspace/route network design (above c.4000ft).	2014	<b>NATS</b>
A1.1.3	Implement LAMP airspace change phase 1.	2015 – 2016	<b>NATS</b>
A1.1.4	Implement LAMP airspace change phase 2.	2016 – 2017	<b>NATS</b>
A1.1.5	Implement LAMP airspace change phase 3 (and 4 if required).	2017 - 2029	<b>NATS</b>
<b>A1.2 NTCA Terminal Airspace Re-design</b>			
A1.2.1	Produce the NTCA airspace / route network design (above c. 4000ft).	2013	<b>NATS</b>
A1.2.2	Consult on the NTCA airspace/route network design (above c.4000ft or the ceiling of the NPR).	2014	<b>NATS</b>
A1.2.3	Implement NTCA airspace change.	2015 - 2016	<b>NATS</b>
<b>A1.3 Terminal and Airport Airspace Re-design – Stakeholder Dependencies</b>			
A1.3.1	Replicate or Re-design SID and approach procedures at low altitudes (below c.4000ft) for PBN.	2013 – 2017	<b>Airports</b>
A1.3.2	Provide fly ability assurance to support the design of the LAMP and NTCA route networks.	2013 – 2015	<b>Operators</b>
A1.3.3	Implement a higher Transition Altitude.	2013 – 2015	<b>CAA</b>
A1.3.4	Provide clarity on the design, analysis and consultation requirements to implement PBN procedures.	2013	<b>Regulator</b>

↑ Table 6: A1. Terminal and Airport Airspace Re-design

## A2. Upper Airspace Re-design

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56. (A2.1) More direct and free routeing is enabled by the re-design of the upper airspace across the FAB into a more efficient structure based around high-level 'super sectors' that where possible remove fixed airspace boundaries - often as a precursor to implementing a fully free route airspace environment. The use of enhanced ATC toolsets and communications will enable ATC to provide aircraft with their optimal cruising altitudes and speeds as they fly through super sectors.

57. (A2.2) Integration with advanced ATC tools and communications is required to enable controllers to monitor aircraft positions, predict trajectories and detect conflicts in volumes of direct and free route airspace. The introduction of 'flexible sectorisation' enables ATC to dynamically change the shape of sectors of upper airspace to better manage streams of traffic that are unconstrained and therefore generate more fluid peaks and troughs in demand. Data-Link communications will facilitate greater use of aircraft derived data, enabling ATC and flight crews to communicate changes to agreed trajectories based on aircraft performance and/or network constraints.

58. (A2.3) Common FAB procedures and regulatory standards established through implementation of the UK/Ireland FAB Plan, are required to maximise the potential benefits of direct and free routeing in FAB airspace. For example cross FAB multi-sector planning and generic controller validations will be used to enable aircraft to maintain their optimal profiles across airspace boundaries.

59. (A2.4) Integration with the European Network Manager – is required to identify and resolve bottlenecks as development of the ECAC route network is progressed through the Network Management pillar of SES.

↓ Ref.	↓ Dependency	↓ Timescales	↓ Owner
<b>A2. En-route UK/Ireland FAB Airspace Re-design</b>			
A2.1	Design and implement changes to the airspace structure and procedures in high-level sectors of FAB airspace.	2013 - 2017	<b>UK/Ire FAB</b>
A2.2	Integrate changes to structures and procedures in the upper airspace with advanced ATC tools and communications.	2015 - 2020	<b>UK/Ire FAB</b>
A2.3	Establish common procedures and regulatory standards across the FAB and its interfaces with neighbouring airspace.	2013 – 2016	<b>UK/Ire FAB</b>
A2.4	Integrate changes to the upper airspace across the FAB with the European Network Strategy.	2013 – 2017	<b>UK/Ire FAB</b>

↑ Table 7: A2. Upper Airspace Re-design

## A3. Airspace Reserved for Hazardous Activity

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60. Strengthening the integration between Airline Operations, Network Management and Civil/Military processes for reserving Special Use Airspace (SUA) will maximise the route efficiency of flight planning. By managing the reservation of SUA on a 'need to operate' basis – through local negotiation with civil and military users – the availability for commercial air traffic, GA and business aircraft is coordinated efficiently.

61. The procedures and systems that support SUA reservations and the promulgation of information will be enhanced to enable operators to take maximum advantage of available airspace opportunities during their flight planning processes. Effective management of SUA is an enabler for more direct and free routing.

62. (A3.1) *Establishing an Airspace Management Function (AMF)*, as the evolution of the current Airspace Management Cells (AMCs), envisages a capability that includes all SUA in the UK and Ireland FAB and manages the availability of volumes of airspace rather than conditional direct routes – increasing aircraft's ability to optimise their profiles. Allocation of airspace by the AMF will be coordinated through local negotiations with potential users based on the priority of the activity, weather conditions and an assessment of the impact on overall network operations. While there is always room for improvement FUA principles are currently being effectively applied in many areas.

63. (A3.2) *Implementation of advanced ASM tools* concentrates on establishing solutions that encompass all the inputs & outputs required to achieve the successful conjunction of airspace management and flow capacity management, generating an optimal outcome for the network as a whole.

64. (A3.3) Technical interfaces with the Network Manager and Neighbouring States/FABs are required to share up to date information about airspace availability (drawing on civil and military demand data, ATFCM data and Met data) and assess the impact of airspace allocation decisions on the network.

65. (A3.4 and A3.5) *Process re-design and training* – The AMF will need to allocate SUA to appropriate civil and military stakeholders and convey that airspace use to all interested parties. The processes followed to reserve SUAs for hazardous activity or high civil demand will be more dynamic (activation and deactivation at 60 minutes prior to request) and geographically more flexible. Process re-design and training is required to maximise the uptake of available airspace opportunities provided by the AMF across civil and military stakeholders.

66. There is an enduring requirement for the MOD to retain some fixed structure Danger Areas to maintain operational capability, which requires access to SUA in order to meet essential training objectives. While there is greater scope for military aviation assets to make use of Dynamic Mobile Areas, it is less feasible for land-based assets, and to a certain extent to maritime training. Security issues and the level of interoperability that would be required to interact with current and future mission planning tools mean that the MOD's aspirations to make greater use of advanced ASM tools, is dependent on the development of a full CONOPS.

↓ Ref.	↓ Dependency	↓ Timescales	↓ Owner
<b>A3. Airspace Reserved for Hazardous Activity</b>			
A3.1	Enhance the capability of the current Airspace Management Cells to develop an integrated Airspace Management Function.	2015 - 2018	<b>NATS &amp; MoD</b>
A3.2	Where able, expand implementation of advanced ASM tools into military outstations.	2015 - 2018	<b>MoD</b>
A3.3	Establish the technical interfaces with the Network Manager and Neighbouring States / FABs.	2015 – 2018	<b>NATS</b>
A3.4	Deliver the processes and training required to maximise the uptake of available airspace opportunities provided by the Airspace Management Function.	2015 – 2018	<b>Operators</b>
A3.5	Deliver the processes and training required to maximise the uptake of available airspace opportunities provided by the Airspace Management Function.	2015 - 2018	<b>MoD</b>

↑ Table 8: A3. Airspace Reserved for Hazardous Activity

# B1. Arrival Management and Airport Integration

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67. Queue Management seeks to apply more accurate data, better scheduling and integrated tool support to sequence arrival and departure flows, presenting inbound traffic to the terminal environment in an optimal order, on time and on schedule; and de-conflicting outbound traffic from multiple airports.

68. Flights inbound to airports that operate at close to maximum capacity are often subject to congestion that results in queuing and delays. In today's system arrival queues are managed on a 'first come, first served' basis, causing bunching in the terminal environment.

69. The use of stack holding to manage traffic bunching limits airspace capacity, increases controller workload, and burns extra fuel. It is an expensive solution that is increasingly unsustainable. Traffic growth and the trend towards larger gauge aircraft are forecast to put increasing pressure on runways and, if nothing is done, will lead to an increase in stack holding.

70. The main objective of arrival management is to absorb arrival delays in the en-route phase and stream inbound traffic flows so that aircraft arrive in the terminal on time and in an optimal order for landing – removing the need for stack holding in normal operations. Holding in some form may always be necessary to maintain high runway utilisation rates (LAMP envisages the introduction of linear holds such as point merge) but this should average at around 1 to 2 minutes per delayed flight rather than 8 to 9 minutes today. Holds will also need to be designed into any future structure to provide a safe contingency for unusual events such as runway closure.

71. *(B1.1.1 & B1.1.2) Investment in the AMAN toolset.* The Arrival Management capability is founded on the development of controller support tools. The AMAN tool, supplied with better data, will require iterative development to provide support to controllers when delivering efficient flight profiles and optimal sequencing. The AMAN tool is currently being

introduced across the UK and Ireland FAB. Over time the development of a joint European tool, known as XMAN, will increase international cooperation and the scope of arrival management across FAB boundaries. The tools rely on accurate data about flight progress and runway demand. The ability of controller tools to manage delays is also dependent on the accuracy of the schedule and the consistency with which flights arrive on time.

72. *(B1.2.1 & B1.2.2) Airport Departure Planning Information.* The effectiveness of arrival management is dependent on accurate data – sourced from operators – about when aircraft plan to push back. Departure Planning Information (DPI) provided electronically into the network by all airports within the AMAN tool's metering horizon is required to generate an accurate picture of expected runway demand and outbound traffic flows into busy sectors.

73. *(B1.3.1) Scheduling Accuracy.* There is a trade-off between high runway utilisation rates and queuing. Current practice at capacity constrained level 3 airports is to schedule runways to a utilisation rate that aims to ensure that holding delays do not go over an agreed 10 minute maximum. A more strategic approach seeks to ensure that schedules are developed to a greater level of accuracy and enshrine an efficient landing sequence to minimise wake vortex separation.

74. *(B1.3.2 & B1.3.3) Arrival Punctuality.* AMAN tool support and a refined schedule will not generate the expected benefits without an industry wide change in operating behaviours to improve arrival punctuality. Significant training, technological developments and change management interventions are required to enable airlines to manage flights to consistently arrive at a fixed point in terminal airspace on time. One of the most important dependencies on operators in the near term is the removal of buffers built into block times to absorb delays, but which perversely can cause more of it.

↓ Ref.	↓ Dependency	↓ Timescales	↓ Owner
<b>B1.1 AMAN Tool Support</b>			
B1.1.1	Develop a Queue Management capability within the UK/Ire FAB, using ATC support tools (AMAN) to absorb some arrival delays through speed control in the en-route phase and stream traffic to arrive in the terminal in an optimal order for landing.	2013 - 2017	<b>NATS</b>
B1.1.2	Expand the Queue Management capability across FAB boundaries, to increase international cooperation (through a tool known as XMAN), and further the scope to absorb arrival delays and accurately stream traffic.	2017 - 2020	<b>NATS</b>
<b>B1.2 Airport Integration</b>			
B1.2.1	Connect electronically into the network and share accurate departure planning information.	2013 – 2015	<b>Airports</b>
B1.2.2	Update turnaround processes to support the provision accurate departure planning information.	2013 - 2015	<b>Operators</b>
<b>B1.3 Scheduling and Punctuality</b>			
B1.3.1	Refine the accuracy of arrival scheduling.	2013 – 2015	<b>Airports &amp; Operators</b>
B1.3.2	Behavioural changes to improve arrival punctuality including the removal of buffers built into block times to absorb potential delays.	2013 – 2015	<b>Operators</b>
B1.3.3	Policy and regulatory support to help shift the operational and commercial incentives that drive industry behaviours around scheduling and block times to improve arrival punctuality.	2013 – 2015	<b>Regulator</b>

↑ Table 9: B1. Arrival Management and Airport Integration

## B2. Airport-CDM and Departure Management

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75. This section considers greater integration of the turnaround process into the airspace system through Airport Collaborative Decision Making (A-CDM); and, Departure Management – increasing coordination across multiple airports to de-conflict outbound traffic flows.

76. In today's airspace system demand and capacity planning across airports, airlines, ANSPs and ground handling agents is not well informed by accurate estimates of aircraft target take-off times. Traffic management based on "static" flight plan information – estimated times of arrival (ETAs) and estimated off blocks times (EOBTs) – does not generate efficient operational outcomes across large capacity constrained airports. As a result inbound, turnaround and outbound traffic flows are not managed as a continuous process chain. Inefficient tactical interventions are needed to smooth the flow of traffic and manage interactions.

77. (B2.1.1 & B2.1.2) *Airport Collaborative Decision Making (A-CDM)* aims to better balance the demand for capacity constrained runways by generating and sharing accurate information about when each flight is able to push back with all relevant parties. A-CDM concentrates on the production and circulation of accurate target off block times (TOBT) and target start-up approval times (TSAT) for every departure. The increased visibility will enhance ground handling processes, enable operators to plan their turnaround operations more effectively and reduce ATC workload.

78. The introduction of an optimal departure sequence through A-CDM, combined with the use of variable taxi times, will reduce queuing at holding points on the airfield and increase runway utilisation rates through greater slot adherence. Significant network benefits are also expected as more adjacent airports adopt A-CDM processes and share their data, increasing the efficiency of flow management across the network.

79. (B2.2.1) *Departure Management* aims to smooth out points of excess demand in outbound traffic flows, particularly where SIDs from multiple airports interact around a common sector. It is envisaged an analysis of outbound demand (supported by DMAN tools) will generate an optimal sequence of TSATs that can be metered to a SID point (rather than the runway) minimising the interactions that must be managed tactically.

↓ Ref.	↓ Dependency	↓ Timescales	↓ Owner
<b>B2.1 Airport Collaborative Decision Making</b>			
B2.1.1	Implement A-CDM systems, where required at capacity constrained airports.	2013 - 2017	<b>Airports</b>
B2.1.2	Adapt processes to collaborate with A-CDM systems and provide accurate TOBTs and TSATs.	2013 - 2017	<b>NATS</b>
<b>B2.2 Departure Management</b>			
B2.2.1	Integrate Departure Management systems with Airport CDM, planning and operations.	2017 – 2020	<b>NATS</b>

↑ Table 10: B2. Airport CDM and Departure Management

## B3. Network Management across the FAB

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80. ANSPs' plans to advance the Network Management capability across the UK/Ireland FAB are a key dependency that underpins the successful implementation of many other sections of the deployment plan.

81. Network Management seeks to maximise the efficiency of the airspace system through continuous integration of an overall Network Operations Plan (NOP) with Airline Operations Plans (AOPs). The capability concentrates on applying the same kind of information sharing and collaborative decision making principles described at an airport level for A-CDM, to the management of airspace capacity. Network Management is a key enabler for:

- More direct and free routeing (A2)
- Effective Management of Special Use Airspace (A3)
- Arrival Management (B1)

82. *(B3.1) Sub Regional Network Management* concentrates on the integration of the Regional Network Manager (Eurocontrol) with the Sub-Regional (FAB) and Local (Unit/Airport) Network Management functions. The Regional Network Manager acts as the central provider of information about airspace demand and capacity shortfalls across the network. Sub-Regional and Local Network Management functions act on this information to balance demand and capacity across the FAB in negotiation with operators. It is envisaged the NOP and AOPs will be dynamically updated to reflect the most accurate view of operator's planned use of airspace.

83. *(B3.2) Development of Airline Operations Centres.* Network Management is the foundation upon which the concept of trajectory operations is based. The SESAR target concept ultimately envisages the exchange of trajectory information between airborne and ground systems during flight. As an interim step, within the timescales of FAS, the capability of Airline Operations Centres will be developed to provide pre-flight, or 'pseudo' trajectory information, including enhanced flight plan data and performance parameters to support ATC in providing aircraft with optimal profiles.

↓ Ref.	↓ Dependency	↓ Timescales	↓ Owner
<b>B3. Network Management across the FAB</b>			
B3.1	Investment in Sub-Regional (FAB) and Local Network Management functions, including resources, process re-design tool support and technical interfaces.	2013 – 2017	<b>UK/Ire FAB</b>
B3.2	Develop Airlines Operations Centres, including resources, process re-design, tool support interfaces to maximise the potential flight planning benefits.	2015 – 2020	<b>Operators</b>
(B1.2.1 and B2.1.1)	Enhance Airports interfaces with Network Management functions to ensure Network and Airport constraints are accounted for and balanced, based on DPI/ACDM data.	2013 – 2017	<b>Airports</b>

↑ Table 11: B3. Network Management across the FAB

# C1. PBN Implementation

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84. This section considers the approach to deployment of Performance Based Navigation (PBN) in the terminal environment and at low altitudes around airports; along with the evolution of Communications and Surveillance capabilities and the introduction of advanced ATC toolsets.

85. The introduction of PBN is being promoted through the ICAO Global ATM Plan and the European Commission has proposed a PBN Implementing Rule (PBN IR) planned for the 2018 to 2020 timeframe to introduce the capability in a consistent manner across Europe. FAS aims to ensure the use of PBN as early as possible as a key enabler for many of the improvements described in the deployment plan.

86. (C1.1.1, 1.2 & 1.3) *Airspace Re-design for PBN*. The advanced navigational capability of many aircraft is significantly under used in today's system, especially in the terminal airspace and at low altitudes around key airports, where much of the fleet is already equipped and there is the greatest potential to realise benefits. FAS aims to assure the costs incurred by operators to equip their fleets to a particular navigation standard are met by performance improvements derived through changes to the airspace design in a corresponding timeframe.

87. Changes to terminal and airport airspace will be designed to PBN standards - in the near-term RNAV1. PBN enables the implementation of closer spaced, more precise routes that facilitate the systemisation of today's tactical arrangements. PBN is also the navigational standard required for more advanced air traffic management concepts such as required time of over flight that will be used to support the evolution of arrival management.

88. Around airport's PBN enables standard arrival and departure procedures to be optimised to better manage noise impacts on the ground, increase runway throughput and strengthen resilience for precision landing aids (e.g. ILS). NATS also has an imperative to rationalise navigation infrastructure where required to optimise ground and space-based aids for PBN implementation. The rationalisation of conventional ground-based navigation aids may become the catalyst to implement space-based PBN capabilities at some airports.

89. (C1.2.1 & C1.2.2) *Central Coordination of PBN Implementation*. The CAA's PBN Policy describes the UK's ambition to adopt PBN in the terminal environment and around airports (basic PBN capability is already mandated in the en-route airspace). An accompanying information note describes the expected transition to a full PBN environment, naturally incentivised by the evolution of fleet capability and potential for operational and environmental improvements. However recent experience has demonstrated 'natural adoption' is not driving PBN implementation in the timescales required for FAS. There are three main reasons:

- 1: Mixed equipage levels and uncertainty around fleet investment plans make it difficult to re-design the airspace for maximum benefit.
- 2: The need to maintain conventional procedures for a period of time can result in additional cost, complexity, workload and safety risks that are a barriers to change.
- 3: Lack of clarity and awareness about PBN design criteria and the use of temporary alternatives may lead to missed opportunities to realise early benefits.

90. In response, the CAA will lead a centralised programme to coordinate the implementation of PBN. The programme will concentrate on the use of mandates to drive adoption of PBN in certain areas of the network and on specified routes. Impact assessments will be undertaken by the regulator in conjunction with industry to guide the transition to full PBN adoption in these areas. The programme will also seek to expedite implementation of simpler PBN replications at low altitudes around airports and promote the use of more advanced capabilities (RNP) where there is a sufficiently high level of equipage and the potential to realise significant benefits.

91. Conventional alternatives will probably be required during the transition. The programme will ensure alternatives are clearly defined and acceptable for both the terminal and en-route environments. The way in which alternatives are used to stage the withdrawal of conventional procedures and incentivise adoption, for example through concepts such as best equipped best served, will also be coordinated as part of the CAA led programme.

92. (C1.3.1 & C1.3.2) *Operator equipage and certification for RNAV1 where required.* Precision RNAV (known as P-RNAV or RNAV1) provides a level of navigational accuracy of +/- 1 nautical mile (NM) either side of a route centreline for 95% of the time. RNAV1 will form the basis of terminal procedure re-designs (See A1) and will therefore be the required standard for aircraft operating in designated airspace. The majority of aircraft operating in the UK terminal environment are equipped and registered for RNAV1 – many are capable of flying to more advanced Required Navigational Performance (RNP) standards.

93. A minority of the fleet are not RNAV1 capable – some in this minority (especially GA and Military users) are unlikely to become so with or without a mandate because the costs are prohibitive for their operations. Other operators have stated in focus group meetings that they will not undertake to become RNAV1 compliant until a mandate is in force and there are corresponding PBN enabled changes to the airspace. The current regulatory process for certification and air worthiness approval for the installation and operation of PBN equipment can be prohibitively expensive for many in the GA and business aviation communities. The cost of approvals (administered by EASA) presents a risk to PBN implementation if it results in the need for sub optimal ‘mixed operations’ in airspace designated to a PBN standard because a proportion of the user community are not equipped.

94. Because of issues associated with MOD procurement cycles and the ability to upgrade complex aircraft platforms it should be recognised that some military aircraft will never be PBN compliant. Nevertheless, military operations should not be hindered by access to airspace.

95. (C1.3.3) *Operator equipage and certification for Advanced-RNP (A-RNP) where required.* A-RNP is used to describe the navigation performance and functionality envisaged for more advanced applications and has been identified as the baseline for the PBN-IR. A-RNP is predicated on use of GNSS as the primary navigation sensor. The navigation specification is likely to contain core functions applicable for both the en-route and terminal environment. The main difference from today’s specifications is the requirement for on-board performance monitoring and alerting. The transition to a full RNAV1 environment does not preclude elements of RNP functionality being used earlier where tangible benefits can be demonstrated from their application. It is envisaged commercial air traffic will equip and certify where the investment to implement elements of RNP is supported by a positive business case.

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## PBN International Best Practice

96. As implementation progresses FAS deployment will seek to incorporate best practice drawn from engagement with the world's leading airports and global airlines. Insights from abroad will be used to inform airspace design concepts, the approach to implementation and engagement with the regulator. A best practice review of PBN implementation at airports in the USA, led by NATS, BA and Heathrow Airport Holdings has generated some important findings for a number of FAS initiatives.

97. The pilot introduction of RNP standards to achieve parallel approaches in Seattle has demonstrated the significant potential to increase runway throughput, save track miles and reduce controller workload. Highly repeatable radius to fix (RF) turns allow for reduced separation on an RNP final approach, parallel to an ILS approach. Work is on-going to fully implement the new arrangements, but Seattle's experience to date has revealed some important lesson for FAS, including:

- The production of safety cases for new airspace concepts where ICAO guidance doesn't currently exist should be viewed as an opportunity to shape the rules, working closely with the local regulator and informed by data drawn from pilots and operational trials.
- Airline/flight crew involvement in the design of advanced airspace concepts – driven by strong engagement from a lead operator – is critical to get the most out of the network.
- The phased implementation of a commonly agreed airspace vision, making changes in small steps, allows controllers and flight crew to build both confidence and competence, and enables issues to be tracked and resolved in a manageable environment.

98. In Atlanta a full RNAV1 environment was implemented in two years. Since then the airport has seen a significant improvement in departure profiles and runway throughput. There are several key lessons for FAS initiatives, including:

- The key to unlocking the benefits of RNAV1 parallel approaches and departures is defining when the aircraft is 'established on the procedure' and responsibility shifts to the pilot for compliance. In Atlanta aircraft are deemed separated when they are established on RNAV1 routes that diverge by more than 6 degrees, enabling one minute departure intervals.
- The implementation of RNAV1 inbound routes has been used to significantly reduce track miles over conventional operations across the terminal environment.
- RNAV1 inbound routes release capacity for controllers to concentrate on aircraft speeds rather than the heading and level changes, ensuring minimum safe separation on final approach, and laying the foundation for time based separation.
- The shift in the controller's role to encompass more monitoring and less intervention is a significant cultural change that needs to be actively managed and incorporated as part of the implementation programme.

↓ Ref.	↓ Dependency	↓ Timescales	↓ Owner
<b>C1.1 Airspace Re-design for PBN</b>			
C1.1.1	Design PBN procedures for LAMP and NTCA airspace.	2013 - 2018	<b>NATS</b>
C1.1.2	Share intentions to replicate or re-design SIDs and arrival procedures at low altitudes (<c.4000ft) for PBN.	2013 – 2015	<b>Airports</b>
C1.1.3	Rationalise navigation infrastructure where required to optimise ground and space-based aids for PBN implementation.	2013 to 2018	<b>NATS</b>
<b>C1.2 Central Coordination of PBN Implementation</b>			
C1.2.1	Produce location specific impact assessments to support the tailored use of mandates and guide the transition to full PBN adoption.	2013 - 2014	<b>Regulator</b>
C1.2.2	Coordinate a central programme to expedite the implementation of PBN SIDs and arrivals at airports.	2013 – 2015	<b>Regulator</b>
<b>C1.3 Operator equipage and certification</b>			
C1.3.1	Equip and certify fleets to meet RNAV1 navigation capability where/when required in the terminal environment.	2013 – 2018	<b>Operators</b>
C1.3.2	Transition towards an appropriate and equivalent level of PBN capability.	2013 – 2018	<b>MoD</b>
C1.3.3	Equip and certify fleets to meet RNP navigation capability where required.	2013 – 2020	<b>Operators</b>

↑ Table 12: C1. PBN Implementation

## C2.1 Advanced ATC Toolsets

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99. NATS' two-centre operation – Swanwick and Prestwick – hosts a variety of different ATC technologies, which are broadly based on the same underlying infrastructure. The future strategy is to align the operations around a common toolset, while allowing for flexibility across the controller disciplines (en-route, terminal and final approach).

100. (C2.1.1) *The Electronic Flight Data (EFD) System*, established in Area Control (AC) and under implementation in Prestwick Centre (PC), substitutes paper strips on an electronic display, reducing controller workload (however conflict detection is still a human cognitive task). EFD is a key enabler for the deployment of Data-Link (see C2.2).

101. (C2.1.2) *Implementation of IFACTS functionality*. The core of IFACTS functionality, focused on tactical trajectory management, supports many of the near-term changes envisaged in FAS. AC at Swanwick is based around the IFACTS system that incorporates tools to manage the tactical trajectory of a flight and coordinate flights between sectors electronically. It is envisaged similar tactical support tools will be introduced across the operation over the life of the FAS to enable more efficient management of trajectories.

102. (C2.1.3) *Implement NATS Common Workstation*. The NCW infrastructure will introduce a common toolset and controller interface across the operations and will host a variety of interchangeable applications including IFACTS, ITEC, EFD, Data-Link and the evolution of the Queue Management toolset.

103. (C2.1.4) *Migrate from NAS flight data processing systems to ITEC*. Over the long term the established flight data processing system (NAS) will be replaced by ITEC, significantly enhancing flight data prediction, management and distribution. ITEC is a key enabler for 4D trajectory operations, producing accurate information regarding aircrafts intended trajectories and greater integration with the Network Manager.

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↓ Ref.	↓ Dependency	↓ Timescales	↓ Owner
<b>C2.1 Advanced ATC Toolsets</b>			
C2.1.1	Implement Electronic Flight Data Systems in the en-route ATC operation.	2013 – 2017	<b>NATS</b>
C2.1.2	Expand implementation of IFACTS functionality across the ATC operations.	2013 - 2018	<b>NATS</b>
C2.1.3	Introduce NATS Common Workstation across the ATC operations.	2016 - 2020	<b>NATS</b>
C2.1.4	Introduce ITEC as the next generation flight data processing system.	2016 - 2020	<b>NATS</b>

↑ Table 13: C2.1 Advanced ATC Toolsets

## C2.2. Communications

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104. From a communications perspective the key stands relevant to FAS are the evolution of voice communications in the context of increasing VHF frequency congestion and the introduction and utilisation of Data-Link capability in the en-route, terminal and airport environments.

105. *(C2.2.1) Convert applicable frequencies to 8.33 kHz.* VHF radio spectrum frequencies dedicated to navigational aids and air traffic control are a scarce resource. VHF congestion is an issue for ATM. A reduction in the channel spacing for voice communications from 25kHz to 8.33kHz will effectively triple the number of frequencies available for aviation stakeholders. A SES implementing rule to enforce mandatory carriage of 8.33kHz radios above FL195 is in place and has initiated a programme of conversion across Airlines, Airports and ANSPs. Requirements for carriage below FL195 are anticipated in 2013.

106. *(C2.2.2) Implementation of initial Data-Link.* Data-Link is the core of the ICAO defined future communications system, enabling higher volumes of information to be shared, more quickly and consistently over greater distances with less potential for misinterpretation or misunderstanding. In the near term the introduction of Data-Link facilitates greater automation and rigour of communications by removing voice radio transmissions from many routine messages and clearances.

107. *(C2.2.3) Expansion of initial Data-Link - A SES* Data. Link Services Implementing Rule applicable to ANSPs and operators is in place and aims to drive the introduction of Data-Link into the en-route (above FL285). It is envisaged fuller adoption of the technology at lower altitudes and in the terminal environment will be driven by commercial incentives as airlines, ANSPs and airports begin to use the capability to enable operational improvements.

108. The key feature of enhanced Data-Link is the capability to use aircraft derived data, enabling ground systems and the aircraft's FMS to communicate changes to its agreed trajectory based on the aircraft's performance and/or network constraints. The continued advancement of Data-Link is largely dependent on the rate of further aircraft equipage.

↓ Ref.	↓ Dependency	↓ Timescales	↓ Owner
<b>C2.2 Communications</b>			
C2.2.1	Convert all applicable frequencies to 8.33 kHz.	SES IR	<b>Operators, Airports, ANSPs</b>
C2.2.2	Equip fleet with initial Data-link.	SES IR	<b>Operators, Airports, ANSPs</b>
C2.2.3	Expansion of initial Data-link capability driven by commercial incentives.	2016 - 2020	<b>Operators, Airports, ANSPs</b>

↑ Table 14: C2.2 Communications

## C3. Layered Surveillance Solutions

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109. From a surveillance perspective FAS considers the advancement of non-cooperative independent surveillance capabilities through the replacement of primary radar, and the introduction of ‘cooperative’ layers of performance-based surveillance according to the type of aircraft and the airspace it is flying in.

110. Primary Radar – a core regulatory requirement under current arrangements – is expensive to maintain, uses large sections of lucrative spectrum frequency and is susceptible to interference from the growing number of wind farms. The drawdown of existing ground-based infrastructure is a catalyst to consider what might replace this and still provide the necessary navigation surveillance capability, especially in low-density and low-complexity airspace, for example in the Scottish Highlands and Islands area.

111. FAS considers the introduction of Multi-static Primary Surveillance Radar (PSR), which is cheaper to maintain, not impacted by wind farms and would enable the release of large sections of spectrum. The benefits of Multi-static PSR support a commercial case for ANSPs and airports to migrate away from Primary Radar. It is envisaged a UK Government backed programme to trial the introduction of Multi-static PSR and re-coup the costs through sale of spectrum would provide the initial impetus and help prove the viability of the technology. The definition of this programme is currently being progressed by the regulator and Government.

112. The introduction of a cooperative surveillance environment also incorporates the use of aircraft-derived data to determine and monitor aircraft positions and the application of this capability to deliver more effective traffic management. This capability is already progressing through the use of Mode S transponders and the introduction of aircraft-based ADS-B. There is a requirement on FAS for the transition arrangements to facilitate non-compliance as not all aircraft will be ADS-B equipped.

113. As they are deployed, new surveillance capabilities will be ‘layered’ to provide efficient solutions, depending on the requirements of the particular volume of airspace. For example in the busy terminal environment, due to the greater levels of integrity and resilience required, ADS-B and Mode-S may be supported by primary radar (or a Multi-static PSR substitute). In the less congested areas Mode S and ADS-B may suffice.

↓ Ref.	↓ Dependency	↓ Timescales	↓ Owner
<b>C3 Surveillance</b>			
C3.1	Trial introduction of new surveillance capabilities in low density airspace.	2013 – 2015	<b>Regulator</b>
C3.2	Change to Regulatory Safety Standards - Primary Radar is currently a regulatory requirement for all environments when in some cases cooperative surveillance capabilities may suffice.	2013 - 2015	<b>Regulator</b>
C3.3	Deployment of cooperative surveillance capabilities on the ground and in the air.	2018 onwards	<b>Operators, Airports, ANSPs</b>

↑ Table 15: C3. Layered Surveillance Solutions

## 6. Conclusion

114. Large scale investment in our airspace has often been deterred by the up front costs, high risks and complex interdependencies. Small incremental improvements progressed instead have added complexity and belie the potential to achieve significant network wide benefits. The deployment plan aims to provide the catalyst to generate true cross-industry buy-in and commitment for the changes required to modernise the airspace system.

115. Commitment to support the FAS deployment plan will be captured in a cross-industry Memorandum of Understanding (MOU). The MOU aims to include all organisations collaborating in the deployment plans. It is not a legally binding document but demonstrates the broad base of support for FAS and sets out the roles and responsibilities of different stakeholder groups in more detail. The MOU also captures many of the operational and commercial issues faced by the organisations involved. The effectiveness of the transition to a future airspace system will be dictated by how these issues are addressed.

116. From January 2013 a cross-industry FAS Coordination and Oversight function will govern implementation of the FAS Deployment Plan. The function will be led by NATS and the CAA with representation from airlines, airports, the DfT, MoD and IAA to ensure close management of the dependencies between industry implementation plans and the policy and regulatory enablers. It will concentrate on tracking progress against detailed delivery plans (levels 2 and 3); coordinating system safety assurance; managing the cross-industry dependencies and resolving issues that might impact the achievement of key milestones. The function will oversee the refinement of the network level cost / benefit analysis that supports FAS and take accountability for benefits realisation. As the first phase of FAS implementation progresses, coordination and oversight will also be required to ensure the alignment with Government aviation policy, SESAR outputs and Single European Sky legislation supports the modernisation of the airspace system in the UK and across the UK / Ireland FAB.

### ↓ The FAS Industry Implementation Group



# Glossary

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↓ Abbreviation	↓ Description
<b>AC</b>	Area Control
<b>A-CDM</b>	Airport Collaborative Decision Making
<b>ACL</b>	Airports Coordination Limited
<b>ADS - B</b>	Automatic Dependent Surveillance - Broadcast
<b>AFIS</b>	Aeronautical Flight Information Service
<b>AMAN</b>	Arrival Management
<b>AMC</b>	Airspace Management Cell
<b>AMF</b>	Airspace Management Function
<b>ANO</b>	Air Navigation Order
<b>ANSP</b>	Air Navigation Service Provider
<b>ANS</b>	Air Navigation Services
<b>AOP</b>	Airline Operations Plan
<b>APC</b>	Approach Control
<b>ASBU</b>	Aviation System Block Upgrade
<b>ASM</b>	Airspace Management
<b>ATC</b>	Air Traffic Control
<b>ATM</b>	Air Traffic Management
<b>CBA</b>	Cost Benefit Analysis
<b>CCO</b>	Continuous Climb Operations
<b>CDO</b>	Continuous Descent Operations
<b>CDR</b>	Conditional Direct Routes
<b>CFIT</b>	Controlled Flight into Terrain
<b>CTOT</b>	Calculated Take Off Time
<b>DAP</b>	Directorate of Airspace Policy CAA

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<b>DPI</b>	Departure Planning Information
<b>EFD</b>	Electronic Flight Data
<b>EOBT</b>	Estimated Off Blocks Time
<b>ETA</b>	Estimated Time of Arrival
<b>FAB</b>	Functional Airspace Block
<b>FACTS</b>	Future Area Control Tool Support
<b>FAS</b>	The UK's Future Airspace Strategy (as published by CAA in June 2011)
<b>FASIIG</b>	Future Airspace Strategy Industry Implementation Group
<b>FAS OG</b>	Future Airspace Strategy Oversight Group (CAA, NATS, DfT, Industry, MoD, GA)
<b>FAS PB</b>	Future Airspace Strategy Programme Board (CAA)
<b>FDMOU</b>	FAS Deployment Memorandum of Understanding
<b>FIR</b>	Flight Information Region
<b>FUA</b>	Flexible Use of Airspace
<b>GBAS</b>	Ground Based Augmentation System
<b>GHG</b>	Green House Gas
<b>GNSS</b>	Global Navigation Satellite System
<b>IAA</b>	Irish Aviation Authority
<b>ICAO</b>	International Civil Aviation Organisation
<b>IFACTS</b>	Interim Future Area Control Tool Support
<b>ILS</b>	Instrument Landing System
<b>ITEC</b>	Interoperability Through European Collaboration
<b>KPA</b>	Key Performance Area
<b>LAC</b>	London Area Control
<b>LAMP</b>	London Airspace Management Programme
<b>LARA</b>	Implementation of the Local and Regional Airspace Supporting System

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<b>LTC</b>	London Terminal Control
<b>MOCOR</b>	Maturity of Cross Organisational Relationships
<b>NTCA</b>	Northern Terminal Control Area
<b>NCW</b>	NATS Common Workstation
<b>NOP</b>	Network Operations Plan
<b>NPP</b>	National Performance Plan
<b>NPR</b>	Noise Preferential Route
<b>MoD</b>	Ministry of Defence
<b>PBN</b>	Performance Based Navigation
<b>PBN-IR</b>	Performance Based Navigation – Implementing Rule
<b>PC</b>	Prestwick Centre
<b>RF</b>	Radius to Fix
<b>RNP</b>	Required Navigational Performance
<b>SBAS</b>	Satellite Based Augmentation System
<b>SES</b>	Single European Sky
<b>SESAR</b>	Single European Sky ATM Research
<b>SID</b>	Standard Instrument Departure
<b>SRG</b>	Safety Regulatory Group
<b>STAR</b>	Standard Arrival Route
<b>SUA</b>	Special Use Airspace
<b>TA</b>	Transition Altitude
<b>TBS</b>	Time Based Separation
<b>TOBT</b>	Target Off Blocks Time
<b>TTOT</b>	Target Take Off Time
<b>TSAT</b>	Target Start-up Approval Time

# FAS Deployment Plan, Iteration 3, V1.2

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