



BRIEFING PAPER

Number 8304, 15 May 2018

Prospects for combat air: What follows Typhoon and Lightning?

By Louisa Brooke-Holland

Contents:

1. What is the combat air strategy?
2. Response to the announcement of the strategy
3. The UK's aerospace industry
4. What combat aircraft does the RAF currently fly?
5. £18bn on combat air over the next decade
6. Weapons
7. Lightning: Stick with F-35B or switch to F-35A?
8. The Future Combat Air System Technology Initiative
9. International collaboration
10. A single platform or a system of systems?
11. Flight Training
12. A defence space strategy?



Contents

Summary	4
1. What is the combat air strategy?	6
1.1 Context	6
1.2 Parliamentary pressure	6
1.3 Announcement	7
2. Response to the announcement of the strategy	9
3. The UK's aerospace industry	10
3.1 About the UK aerospace sector	10
3.2 Protecting European industry?	11
3.3 Exporting Typhoon	12
4. What combat aircraft does the RAF currently fly?	13
5. £18bn on combat air over the next decade	15
6. Weapons	16
7. Lightning: Stick with F-35B or switch to F-35A?	18
8. The Future Combat Air System Technology Initiative	19
9. International collaboration	20
UK and France agree to collaborate...	20
...but France switches to Germany	20
So where does this leave the UK?	21
10. A single platform or a system of systems?	23
11. Flight Training	25
12. A defence space strategy?	26

Summary

The Ministry of Defence is developing a Combat Air Strategy as part of the Modernising Defence Programme. The aerospace sector accounted for 70% of UK defence exports in 2016 and the Government describes the UK as a leader in air sector technology and capability.¹

MPs have been calling for a sector analysis of the defence aerospace industry for some time.² Last year the MOD published a National Shipbuilding Strategy which laid out the Government's plans to work with Industry to develop future navy surface ships, starting with the new Type 31e frigates. The Ministry also refreshed its defence industrial policy last year and, early this year, launched the Modernising Defence Programme.

The MOD has not indicated when the Strategy will be released. It has said the headline conclusions of the Modernising Defence Programme will be announced in time for the next NATO Summit (11-12 July 2018).³

Assessing the options for the UK's future combat air requirements

The MOD says the strategy will "set the framework and timeline to assess options for the UK's future Combat Air requirements and associated decision making". One driver of the strategy is the need to begin thinking now about what combat air capabilities the RAF will be flying in the 2040s.

The RAF currently flies Tornado and Typhoon aircraft and will shortly introduce the new stealthy Lightning aircraft. Tornado will then retire in 2019, leaving Typhoon and Lightning to continue in service for the next couple of decades. The MOD has yet to decide on the choice of variant of the remaining 90 F-35 aircraft it intends to order.

The Government says some key decisions will need to be made in the early 2020s about what will come after Typhoon. Main Gate (when the main investment decision is taken) is pencilled in for 2025.⁴

The Future Combat Air System

Work has already begun on possible options under the Future Combat Air System Technology Initiative. Any new combat aircraft is likely to be developed with at least one other country. The UK has been working with France for the last few years on an unmanned combat air system demonstrator programme. However, the future of that was thrown into doubt last year when France teamed up with Germany to develop its own Future Combat Air System.

Unlike the National Shipbuilding Strategy, which focused heavily on the initial need for new frigates and longer-term on replacements for other vessels, the Combat Air Strategy may scope out the alternative or additional ways defence can fulfil the requirements of combat air that are not confined to the traditional combat aircraft model.

£18bn on combat air

The MOD has allocated £18bn over the next ten years to the combat air sector. About half is allocated to Lightning procurement and support and the rest for Typhoon capability enhancements, unmanned air systems and military flying training. A further £13bn will be spent on weapons, including integrating air-to-ground weapons onto Typhoon and the new SPEAR missile for Lightning.

¹ [UK defence and Security export statistics for 2016](#), Department for International Trade, 25 July 2017,

² MPs debated a defence aerospace industrial strategy on [16 November 2017](#)

³ [PQ133407](#), 27 March 2018

⁴ [HC Deb 19 November 2017 c689](#); Ministerial letter to Jack Lopresti, 10 November 2017, [DEP2017-0691](#)

Positive response from industry and unions

UK industry and unions have broadly welcomed the focus on Combat Air and the Government's pledge to "consider operational capability, technological advantage, economic benefits, industrial capability, capacity and skills, as well as international partnering, wider prosperity and export potential."⁵

ADS, the trade body for the aerospace and defence industry, said it presented an opportunity for industry and Government to "work together to ensure the UK remains a world leading military air power and a highly competitive and capable option in the export market. The trade union Unite called on the Government to "move swiftly to secure the UK's ability to build combat aircraft and ensure that capability isn't outsourced to foreign powers".

Protecting and retaining UK skills and jobs is a significant concern for UK and European industry. Airbus and Dassault Aviation explicitly cited the need to retain European sovereignty and strategic autonomy when they agreed to work together on developing and producing a Future Combat Air System capability for France and Germany.⁶

A defence space strategy?

It is unclear whether the Strategy will also discuss defence space policy or whether this will be a separate strand. The current disagreement between the UK and the EU over the UK's access to the Galileo satellite navigation system after Brexit has brought space to the fore.

Box 1: What are combat aircraft?

Combat aircraft carry a range of weapons designed to destroy enemy targets in the air or on the ground. Their primary role is combat – as opposed to transport or reconnaissance. They may be designed for different roles. For example, fighter aircraft are designed for air superiority - to engage with enemy aircraft in air-to-air combat – and police the skies – while ground-attack aircraft are equipped with air-to-ground missiles and may provide close air support to ground forces. Multirole aircraft perform both air-to-air combat and ground attack. Combat aircraft may also perform intelligence and reconnaissance missions.

⁵ [HCWS479](#), 22 February 2018

⁶ "[ILA: Airbus, Dassault cement FCAS pact](#)", Flight Global, 25 April 2018

1. What is the combat air strategy?

1.1 Context

In late 2017 the Ministry of Defence published two documents relevant to the Combat Air Strategy - The National Shipbuilding Strategy and the Defence Industrial Policy. Their publication fulfilled commitments made in the 2015 Strategic Defence and Security Review. There was no mention in the SDSR of a combat air strategy.

The first is relevant because it focused on a specific sector. The **National Shipbuilding Strategy** examined the UK's naval shipbuilding industry and outlined a 30 year 'masterplan' for future naval surface ships, beginning with the new Type 31e frigates. Key proposals are to compete for, rather than single-source, the procurement of the frigates, and to design and build them to be exportable.⁷

The second is the **Defence Industrial Policy** refresh. Highlighting the importance of combat air to the UK defence industry – aerospace accounted for 85% of the UK's defence export orders over the last ten years (2007-16) – the paper suggested combat air could benefit from a specific sector approach “to help deliver long-term value for money, operational advantage of freedom of action”.⁸

The Government also published a wider [Industrial Strategy](#) in November 2017 which discussed the civil aerospace industry. The National Security Strategy Capability Review, published in March 2018, confirmed the intention to develop a Combat Air Strategy.⁹

The RAF celebrates its 100th anniversary in 2018.

1.2 Parliamentary pressure

The focus on naval shipbuilding prompted several MPs, led by Ruth Smeeth and Robert Courts, to argue a similar focus should be applied to the defence aerospace sector.¹⁰

Ruth Smeeth argued: “to ensure our sovereign capabilities post-Brexit, we need to develop a defence aerospace industrial strategy now to protect our domestic skill mix”. Ms Smeeth suggested such a strategy “would provide lasting benefits to our economy, retain a valuable skills base, guarantee our sovereign military capability and secure our position on the global stage”.

Robert Courts stressed the long gestation of combat aircraft means decisions cannot be put off. In a debate on 16 November 2017, several MPs emphasised the importance of a strong UK base, including maintaining

The aerospace sector accounted for:

85% of UK defence exports 2007-2016

70% of UK defence exports in 2016

⁷ [National Shipbuilding Strategy: the future of naval shipbuilding in the UK](#), Ministry of Defence, 6 September 2017. Commons Library briefing paper [The National Shipbuilding Strategy: January 2018 update](#), CBP8193, 9 January 2018

⁸ [Industry for Defence and a Prosperous Britain: refreshing defence industrial policy](#), Ministry of Defence, 20 December 2017, paras 58-59.

⁹ [National Security Capability Review](#), Cabinet Office, 28 March 2018, para 10

¹⁰ [HC Deb 16 November 2017 c668-688](#)

skilled engineers and scientists in the sector, to ensure the UK remains competitive in future collaborative programmes.

Harriet Baldwin, responding for the Government, spoke of the UK having “some of the most technically advanced and capable aerospace companies in the world.” On replacing the capabilities currently delivered by Typhoon, the Minister said:

It will be a complex decision, involving a clear military requirement and requiring detailed consideration of the industrial and financial implications. In terms of the timing, the decision will be made in the very early 2020s or sooner to enable a main gate decision on the procurement in or around 2025.¹¹

1.3 Announcement

The Combat Air Strategy was announced on 21 February 2018 by the Defence Secretary in evidence to the Defence Committee. Gavin Williamson said the strategy “will seek to ensure that the UK maintains the ability to operate both independently and as part of international coalitions” and will set out the UK’s future requirements.¹²

More details emerged in a subsequent written statement:

Delivery of battle-winning capability to the UK’s Armed Forces is dependent on a number of vital national technologies and skills. This goes to the heart of our Operational Advantage and Freedom of Action and the Strategy will seek to ensure the UK maintains the ability to operate both independently and as part of international coalitions.

Recognising the importance of the Combat Air sector to UK military capability, Freedom of Action, prosperity and our industrial base, the MOD has decided to develop a Combat Air Strategy as part of the Modernising Defence Programme.

[...]

We will consider operational capability, technological advantage, economic benefits, industrial capability, capacity and skills, as well as international partnering, wider prosperity and export potential.

The aim is to set the framework and timeline to assess options for the UK’s future Combat Air requirements and associated decision making.¹³

Publication

The MOD has not firmly indicated when the Strategy will be published. However, it has said the headline conclusions of the Modernising Defence Programme will be announced in time for the next NATO Summit (11-12 July 2018).¹⁴ Two big aerospace events also take place in July: The Royal International Air Tattoo at RAF Fairford (13-15 July) and Farnborough Air Show (16-22 July).

¹¹ [HC Deb 16 November 2017](#), c668-689

¹² “[Oral evidence: departmental priorities](#)”, Defence Committee, HC 814 2017-19, 21 February 2018, q1

¹³ [HCWS479](#), 22 February 2018

¹⁴ [PQ133407](#), 27 March 2018

Box 2: Scrutiny of aircraft procurement

Parliamentary select committees and the National Audit Office have scrutinised the procurement of current and past combat aircraft. Selected reading:

- [Unclear for take-off? F-35 Procurement](#), Defence Committee, 19 December 2017, HC 326 2017-19
- [Government response: Unclear for take-off? F-35 Procurement](#), Defence Committee, 26 February 2018, HC 845 2017-19
- [Delivering Carrier Strike](#), National Audit Office, 16 March 2017, HC 1057 2016-17
- [Carrier Strike: the 2012 reversion decision](#), National Audit Office, 10 May 2013, HC 63 2013-14
- [Carrier Strike: Supplementary Report](#), National Audit Office, 29 November 2011, HC 1656 2010-2012
- [Carrier strike](#), National Audit Office, 7 July 2011, HC1092, 2010-12
- [Management of the Typhoon project](#), National Audit Office, HC 755 2010-2011
- Management of the Typhoon project, Public Accounts Committee, HC 860 2010-11
- [Transforming Logistics Support for fast jet fleets](#), National Audit Office, 17 July 2007, HC825 2006-2007
- [Delivering front line capability to the RAF](#), Defence Committee, 18 January 2006, HC 557 2005-06

2. Response to the announcement of the strategy

The announcement of a Combat Air Strategy has been welcomed by industry and unions.

ADS, the trade body for the aerospace and defence industry, said it presented an opportunity for industry and Government to “work together to ensure the UK remains a world leading military air power and a highly competitive and capable option in the export market.”¹⁵ ADS spoke of leveraging civil research and development initiatives (including those developed through the Aerospace Growth Partnership) and to focus on key technologies:

The Combat Air Strategy has the potential to give industry the confidence to invest in R&D activities, as well as create apprenticeship schemes, re-position skills and personnel around the country, and align business practices to make the most competitive bid possible. This approach to the next generation of combat air could make the UK the ideal partner for any potential international collaboration programme.¹⁶

Andy Tuscher, the director of NDI, a defence manufacturing trade body, emphasised the importance and role of the UK supply chain:

Our supply chain is as well positioned to engage in multinational procurement programmes as it is domestic, and this must be factored into government thinking on combat air, in a way that the National Shipbuilding Strategy fell somewhat short.¹⁷

He added the Strategy will be “critical in determining the route to ensuring that UK industry can transition to deliver what will follow on” from Typhoon and Lightning.

Unite, the trade union, called for the strategy to “move swiftly to secure the UK’s ability to build combat aircraft and ensure that capability isn’t outsourced to foreign powers”. The union explicitly called on the Government to commit to replacing the Red Arrows fleet of aircraft to secure the future of sites that could be involved in the production of the next generation of combat aircraft.¹⁸

The US company Lockheed Martin said integrating Typhoon with its own F-35 Lightning should be a key component of the Strategy. Lockheed suggested the Government should identify and invest in “unique technology strengths will allow the UK to become the ‘indispensable partner of choice’.”¹⁹

¹⁵ [“ADS response to Government’s new Combat Air Strategy”](#), ADS, 21 February 2018

¹⁶ Andy Johnson, [“Combat air – leveraging our surroundings”](#), ADS blog, 28 March 2018; Emma Booth, [“Combat air – a timely reminder”](#), ADS blog, 7 March 2018

¹⁷ [“NDI Director on the Combat Air Strategy”](#), EEF, 23 February 2018

¹⁸ [“Combat air strategy must support UK jobs and skills, says Unite”](#), Unite, 21 February 2018

¹⁹ [Lockheed Martin UK written evidence to The Modernising Defence Programme](#), Defence Committee, 24 April 2017, MDP0025

3. The UK's aerospace industry

The aerospace sector was responsible for 85% of UK defence exports in the last decade (2007-16) and 70% of UK defence exports in 2016. Significant exports include the sale of Typhoon and Hawk aircraft but the sector includes a wide variety of platforms, equipment and support. The Government describes the UK as a “leader in air sector technology and capability”.²⁰

3.1 About the UK aerospace sector

The UK aerospace sector had a turnover of £31 billion in 2016. It employs 95,000 people, with the greatest number of jobs in the South West and the East Midlands. Nearly 90% of what the sector produces is exported.

South West England and the East Midlands account for 43% of employment in this sector across the whole of the UK.

The UK has some major companies in the global aerospace sector, with both BAE Systems and Rolls-Royce featuring in the global top ten companies by revenue. Further afield, Boeing (United States) and Airbus (Europe) are the largest companies in the sector globally.²¹

The Government is already working with the UK aerospace sector and has set up the Aerospace Growth Partnership to work with industry and the Aerospace Technology Institute to facilitate collaboration between Government and industry. The Government's defence sector analysis said this of the aerospace sector:

As well as equipping the UK Armed Forces, the sector has a strong export performance reflecting internationally competitive product offerings. Key UK products and related support services include fighter and trainer aircraft, helicopters, large aircraft wings, missiles and jet engines. This sector is closely related to the civil aerospace sector with many companies involved in both. Defence aerospace has a significant footprint in the South West (helicopters and engines) and North West (combat aircraft).²²

More on this, as well as a detailed examination of the aerospace industry, including Government policy, profiles of major companies, industry outlook and commentary on the impact of Brexit can be found in Library briefing paper [The aerospace industry: statistics and policy](#), SN00928, 8 November 2017.

Built in the UK?

Unlike warships and submarines, combat aircraft are not required to be built in the UK.²³ However, protecting the UK's operational advantage and

²⁰ [UK defence and Security export statistics for 2016](#), Department for International Trade, 25 July 2017, p12

²¹ Commons Library briefing paper [The aerospace industry: statistics and policy](#), SN00928, 8 November 2017

²² [Sectoral Report – Defence](#), Department for Exiting the European Union Sectoral Analyses inquiry, 21 December 2017

²³ National Shipbuilding Strategy, para 92

freedom of action was explicitly cited in the written statement announcing the Combat Air Strategy:

Delivery of battle-winning capability to the UK's Armed Forces is dependent on a number of vital national technologies and skills. This goes to the heart of our Operational Advantage and Freedom of Action and the Strategy will seek to ensure the UK maintains the ability to operate both independently and as part of international coalitions.²⁴

Tornado was developed as part of a three-nation development between the UK, (then) West Germany and Italy.

Eurofighter Typhoon is the result of a multinational collaborative effort between Germany, Italy, Spain and the UK, dating from the 1980s. BAE Systems, Airbus and Leonardo own the Eurofighter Consortium. Each of the four parent nations host the production line and final assembly for the components of the aircraft it is responsible for. In the UK this is BAE's Warton plant in Lancashire.

The F-35 Lightning is a multinational collaboration with eight partner countries, led by Lockheed Martin in the US. The UK is the only tier 1 partner nation in the F-35 programme, which means UK-based companies will build 15% (by value) of each of the estimated 3,000+ aircraft. More than 100 UK-based companies are involved in the F-35 programme including BAE Systems, GE Aviation, Martin-Baker, SELEX, Cobham, Ultra Electronics, UTC Actuation Systems and Rolls-Royce.²⁵

3.2 Protecting European industry?

France and Germany are planning to collaborate on a Future Combat Air System. Comments by leading companies Dassault and Airbus reflect European industry concerns about the future of the combat aviation industry. There is currently no obvious successor to the three European-designed and built combat aircraft: Eurofighter (BAE Systems, Airbus and Leonardo) Typhoon, Dassault Aviation's Rafale, and Saab's Gripen aircraft.

The CEO of Airbus, Dirk Hoke, explicitly cited the need to protect European "political and industry autonomy and sovereignty in the defence sector" when Airbus launched the Future Combat Air System with Dassault in April 2018. Dassault Aviation's chairman, Eric Trippier, echoed Hoke's comments:

I am convinced that European sovereignty and strategic autonomy can and will only be ensured through independent European solutions.... The FCAS programme will strengthen the political and military ties between Europe's core nations and it will reinvigorate its aerospace industry."²⁶

²⁴ [HCWS479](#), 22 February 2018. The 2012 Defence White Paper [National Security through Technology](#) discusses operational sovereignty in detail, Cm 8278, February 2012

²⁵ [F-35 Lightning II UK participation](#), accessed 4 May 2018

²⁶ ["Airbus and Dassault Aviation join forces on Future Combat Air System"](#), Airbus, 25 April 2018

3.3 Exporting Typhoon

Over the last ten years the Aerospace sector by value accounted for 85% of UK defence exports.²⁷ A significant chunk of that comes from Typhoon.

The UK Defence Secretary signed what he described as the “biggest export deal for the Typhoon in a decade” for 24 Typhoon aircraft for Qatar, in September 2017. The Government said the deal was worth £6bn and would secure work not just for BAE System’s production line at its Warton site, but also support missile company MBDA.²⁸ The Ministry of Defence says a new Typhoon squadron will temporarily integrate Qatari personnel to train their pilots and ground crew.²⁹

The UK is leading the consortium’s bid for contracts with Saudi Arabia and Belgium.³⁰ Other potential markets for Typhoon include Malaysia, India and Germany, which is looking to replace its current Tornado fleet.³¹ The Eurofighter consortium is made up of three partner companies: BAE Systems, Airbus Defence and Leonardo. The programme is managed by the NATO Eurofighter and Tornado Management Agency (NETMA), based in Germany, which acts as the single point of contact for customers and governments.

Typhoon, Rafale and Gripen will remain in service for at least another couple of decades and currently compete for export orders on the global market. US competitors include Boeing’s F-15 Strike Eagle, F/A-18 Hornet and F/A-18E/F Super Hornet and Lockheed Martin’s F-35. Russia and China are also developing fifth generation aircraft. Turkey is also looking to enter the fifth-generation market with its TF-X project.

Box 3: The Red Arrows and Hawk aircraft

The Red Arrows fleet of Hawk T1 aircraft are due to leave service around 2030. Several MPs and the trade union Unite are calling on the Government to commit to replacing the fleet to both ensure the future of the Red Arrows and protect jobs at BAE’s hawk production line. Hawk aircraft are manufactured primarily at Brough in North Yorkshire. In October 2017 BAE Systems announced that it was restructuring its business, including changes to the production lines for both the Hawk and the Typhoon given that current orders are coming to an end and there is a level of uncertainty about future orders. Since then, Qatar has signalled its intention to buy 6 Hawk aircraft. The Government said in December 2017 this commitment will keep the production line going for at least another 12 months.³² The Government has also ruled out what it describes as a “premature purchase” of further Hawk aircraft and said a decision about replacements is unlikely to be taken until the end of this Parliament.³³

²⁷ [UK defence and security export figures 2016](#), Department for International Trade Defence and Security Organisation, 25 July 2017

²⁸ [“Defence Secretary in Doha as multi-billion pound jet contract with Qatar is signed”](#), Ministry of Defence, 10 December 2017

²⁹ [“Defence Minister reveals new RAF squadron at Qatar event”](#), Ministry of Defence, 14 December 2017

³⁰ [“Defence Secretary in Doha as multi-billion pound jet contract with Qatar is signed”](#), Ministry of Defence, 10 December 2017

³¹ [“German ministry sees benefit in keeping fighter jet expertise in Europe”](#), Reuters, 28 February 2018; [“German defence ministry gets bids for Tornado fighter jet replacement”](#), Reuters, 24 April 2018

³² PQ117189, 7 December 2017

³³ [“BAE Systems jobs in Brough”](#), MOD response to a petition P002081, 18 January 2018

4. What combat aircraft does the RAF currently fly?

The RAF's fast combat aircraft fleet consists of two fast-jets: Tornado and Typhoon. Tornado retires in 2019 and will be replaced by the new F35B Lightning. Typhoon will remain in service until 2040 and Lightning until the middle of the century.

Typhoon

Typhoon is a fourth-generation combat aircraft and will remain in service until 2040.³⁴ Its primary role in the RAF is UK air defence and it forms the Quick Reaction Alert Force, ready to scramble at very short notice to identify and intercept any unauthorised aircraft approaching UK airspace. Four Typhoon aircraft are based in the Falkland Islands. The 2015 SDSR announced plans to create two additional squadrons to sit alongside the five existing squadrons.³⁵ These will be formed from older aircraft rather than new buys. The SDSR also committed to upgrading Typhoon with air-to-ground weapons and a new radar among other enhancements. Typhoon squadrons are based at RAF Coningsby and RAF Lossiemouth.

"Typhoon (will) become the backbone for UK combat air forces." National Security Capability Review, March 2018

Tornado

Tornado will leave service in 2019 after nearly four decades in service. They are the RAF's primary ground attack and reconnaissance combat aircraft and the latest version, GR4, has flown in operations in Iraq, Libya and Iraq/Syria. The three frontline squadrons are based at RAF Marham.³⁶ All Tornado GR4 aircraft are to leave service in 2019.³⁷

Lightning (from end 2018)

The RAF's new combat aircraft is the Lightning II F-35B Joint Strike Fighter. It will enter service at the very end of 2018 and from 2019 will partner Typhoon to form the RAF's future fast-jet fleet.

Lightning is the UK designation for the US-led F35 Joint Strike Fighter programme. It is a multirole aircraft with stealthy characteristics, meaning it is designed to operate undetected in hostile airspace. It will be able to conduct air-to-air, air-to-surface, electronic warfare and intelligence gathering missions. It is a fifth-generation aircraft.

The RAF and Royal Navy will jointly operate the aircraft from land and sea. With the new Queen Elizabeth-class aircraft carriers it will provide the UK's Carrier Strike capability. Lightning will be based at RAF Marham.

The first squadron, 617, is expected to declare Initial Operating Capability from land, with nine aircraft, in December 2018. They will be followed by the Operational Conversion Squadron (207) in 2019 and the second

³⁴ It was expected to retire in 2030 but the 2015 Strategic Defence and Security Review extended its life until 2040.

³⁵ National Security Strategy and Strategic Defence and Security Review (Cm 9161), November 2015, para 4.49

³⁶ As of 1 April 2017, UK armed forces equipment and formations 2017, 6 July 2017, table 7

³⁷ [PQ136226](#), 23 April 2018

14 Prospects for combat air: What follows Typhoon and Lightning?

operational unit, 809 Naval Air Squadron, in 2023. Lightning is expected to remain in service until the late 2040s.

Library briefing paper "[The UK's F-35 Lightning II Joint Strike Fighter](#)" contains detailed analysis of the programme up to 2015.

5. £18bn on combat air over the next decade

The Ministry of Defence will spend £18bn on the combat air sector over the next decade (2017-2027). This will include spending on fast jets, unmanned air systems and military flying training and support costs. The Defence Equipment 2017 plan specifically identifies:

- Typhoon capability, including the integration of a suite of weapons and enablers that will enhance the Ground Attack and Air-to-Air roles;
- delivery of the F-35 Lightning II project, which will be a cornerstone of Combat Air operations for decades to come;
- Unmanned Air Systems, bring into core existing capabilities and investing for the future in replacement systems, including the SDSR commitment to more than double the existing Reaper fleet; and
- Military flying training, including new aircraft systems and synthetic training environments to enhance delivery of trained aviators until 2033.³⁸

Reaper, and its replacement, Protector, are not combat aircraft in the conventional sense. Rather they are remotely piloted medium-altitude, long endurance aircraft designed for Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR). However, Reaper can carry weapons for ground-attack missions and has carried out numerous air strikes during Operation Shader in Iraq/Syria. It is categorised by the RAF as an ISTAR capability rather than a combat aircraft. Protector is also intended to be able to carry weapons.

The Equipment Plan does not provide further breakdowns of the £18bn by project. However, the MOD has separately provided more information on F-35 costs:

The Government has publicly disclosed the cost estimate for the procurement of the first 48 F-35 aircraft and their support costs out to 2048 as circa £13 billion. Of this cost, £9.1 billion has so far been approved to cover support to 2020 and delivery of 48 aircraft, with the last of these being delivered in 2024. This is the totality of the UK F-35 procurement programme as specified in the MoD's 10-year Equipment Plan.³⁹

The National Audit Office says the defence equipment is “unaffordable”. Reasons included “forecast costs for supporting new equipment, such as the F-35 Lightning II jets, are inherently immature” and the potential impact of movements in foreign exchange rates – Lightning is priced in US dollars.⁴⁰

³⁸ [The Defence Equipment Plan 2017](#), 31 January 2018

³⁹ Defence Committee, [Unclear for take-off? F-35 Procurement: Government response](#), HC 845 2017-19, 26 February 2018, para 7

⁴⁰ The Equipment plan 2017 to 2027, National Audit Office, 31 January 2018, HC 717 2017-19, para 12 and 2.10

6. Weapons

There are two main types of weapons carried by combat aircraft: air-to-air and air-to-surface.

The MOD has allocated £13.4bn on weapons programmes over the next decade.⁴¹ This includes:

- planned weapon enhancements for Typhoon (project Centurion) which will integrate Meteor, Brimstone and Storm Shadow weapons onto Typhoon by the end of 2018;⁴²
- upgraded ASRAAM for Typhoon and Lightning;
- SPEAR Capability 3, which is an in-development medium-range air-to-surface (land and sea) precision strike missile for Lightning. Provisionally date for Lightning is around 2024.⁴³ Typhoon is the trials platform for SPEAR which suggests it could at some point be integrated onto the aircraft.

Industry providers

MBDA missile systems, a joint venture between BAE Systems, Airbus and Leonardo, provides many of the RAF's air-launched weapons. The Government signed a partnering agreement with MBDA in 2010 to take forward the Government's strategy for complex weapons.⁴⁴ MBDA makes ASRAAM, Brimstone, Meteor, Spear and Storm Shadow, amongst others. The MOD placed a £400m contract with MBDA to develop a 'Brimstone 3' or a Capability Sustainment Programme (CSP) variant of Brimstone 2 for delivery in 2021/22.⁴⁵

US company Raytheon makes the Paveway IV precision-guided bomb carried by Tornado and AMRAAM's for Typhoons.

Lockheed Martin supplies the Hellfire air-to-surface missiles used by Protector.

⁴¹ [Defence Equipment Plan 2017](#), Ministry of Defence, 31 January 2018

⁴² [Letter from the Rt Hon Earl Howe to Lord Campbell of Pittenweem](#), 2 May 2017, Dep2017-0378); [PQ135299](#), 23 April 2018

⁴³ "UK MOD green lights Meteor integration on F-35B", Jane's Missiles and Rockets, 28 April 2017

⁴⁴ HC Deb 29 March 2010 c78WS

⁴⁵ "MBDA to develop 'Brimstone 3'", Jane's Missiles and Rockets, 27 March 2018

WEAPONS

Air-to-air missiles

ASRAAM

Aircraft: Typhoon & Tornado
Function: Advanced short-range (within visual range)
Manufacturer: MBDA

AMRAAM

Aircraft: Typhoon
Function: Advanced Medium range
Manufacturer: Raytheon

Meteor (BVRAAM)

Aircraft: Typhoon from 2018; Lightning in 2020s
Function: Beyond Visual Range
Manufacturer: MBDA

Air-to-surface

Brimstone

Aircraft: Tornado, Reaper, and from 2018 Typhoon
Function: Battlefield targets, close air support
Manufacturer: MBDA

Paveway IV

Aircraft: Typhoon & Tornado
Function: Precision-guided bomb, 500lb warhead
Manufacturer: Raytheon

Storm Shadow

Aircraft: Tornado, from 2018 Typhoon
Function: Cruise missile
Manufacturer: MBDA

Spear Capability 3 (in development)

Aircraft: Lightning
Function: Advanced deep attack
Manufacturer: MBDA

Hellfire

Aircraft: Reaper
Function: missile
Manufacturer: Lockheed Martin

7. Lightning: Stick with F-35B or switch to F-35A?

The UK is buying the Short Take-Off and Vertical Landing (STOVL) B variant of the F-35, one of three variants produced by Lockheed Martin. This variant was selected in 2002 but in 2010 the new Government controversially switched to the Carrier variant. This had a knock-on effect of delaying into service the new aircraft carriers then under construction. In 2012 the Government reversed its position and recommitted to the STOVL variant.⁴⁶

The Government has committed to buying 138 F-35 aircraft and has approved funding for 48 aircraft. These will all be delivered by 2024.

The Ministry of Defence told the Defence Committee the timing and choice of variant of the remaining 90 aircraft “has not yet been determined” and “analysis is under way to determine the choice of variant of the remaining 90 F-35s that meets both Combat Air and Carrier Strike requirements”.⁴⁷ This raises the possibility that they may opt for a mixed fleet of F-35B and F-35A aircraft. This is reportedly favoured by some in the RAF.⁴⁸ The F-35A is land-based – it will not be able fly from the Royal Navy’s aircraft carriers.

⁴⁶ [Commons Library briefing paper](#), The F-35 Joint Strike Fighter, SN06278, 6 February 2015

⁴⁷ Defence Committee, [Unclear for take-off? F-35 Procurement: Government response](#), HC 845 2017-19, 26 February 2018

⁴⁸ [“RAF hints that UK could still opt for mixed F-35 fleet”](#), Flight Global, 8 July 2016

8. The Future Combat Air System Technology Initiative

Preparatory work for the future combat aircraft fleet is already underway. The MOD says the **Future Combat Air System Technology Initiative** will inform the Combat Air Strategy. The Initiative has three core strands:

- international projects, including our work with France
- national projects
- open mission system architecture project⁴⁹

Harriet Baldwin, then Minister for Defence Procurement, mentioned the FCAS TI during the debate on defence aerospace:

The 2015 SDSR allocated a substantial budget over 10 years to the future combat air system technology initiative, precisely to protect and develop key design and engineering skills in our industrial base. The money includes funding for a national technology programme to maintain the UK's position as a global leader in this area. Some of the work to mature other high-end technologies is with France, and some is with the US.⁵⁰

Her successor as Defence Procurement Minister, Guto Bebb, also referenced the Initiative when responding to a petition about defence aerospace jobs:

We are committed, therefore, to keeping the UK a leading aerospace nation and we are already working with industry on our long-term requirements, for example on the Future Combat Air System Technology Initiative. Through this programme, we are working in partnership with the UK defence industry and our closest allies to develop key technologies while also sustaining the UK industrial base.⁵¹

⁴⁹ [PQ133174](#), 22 March 2018

⁵⁰ [HC Deb 16 November 2017 c688](#)

⁵¹ ["BAE Systems jobs in Brough"](#), Ministry of Defence response to petition P002081, 18 January 2018

9. International collaboration

Any new combat aircraft is likely to be developed with at least one other country. Tornado, Typhoon and Lightning were all developed in collaboration with other nations. The most obvious reason for this is cost - combat aircraft are eye-wateringly expensive and additional partners can help (in theory) to diffuse both developmental and through-life costs. The drawback is the potential for complicated management structures, slow decision making and political issues, particularly if a consensus is required from all the partner nations.⁵²

UK and France agree to collaborate...

In 2010 the UK agreed to work with France to fund and develop an Unmanned Combat Air System (UCAS) Demonstrator Programme, building on BAE Systems Taranis and Dassault Aviation's Neuron unmanned combat air vehicle demonstrator programmes, as part of a wider range of cooperative defence initiatives.⁵³

The UK and France signed an agreement in 2016 to enable the next phase of the UCAS programme to begin. The MOD said the demonstrators "will be used for operational test and evaluation work over the following 5-10 years and could serve as the basis for a future operational capability beyond 2030". Rolls Royce and Leonardo are involved on the UK side with Thales and Safran on the French side. The £1.5bn demonstrator programme was at the time expected to begin in late 2017.⁵⁴ However, momentum appears to have stalled. The 2018 UK-France summit communique said only:

Following the Future Combat Air System Development Phase-0, we will continue our work on assessing the emerging conclusions before decisions are taken on future phases. We will also pursue opportunities for Combat Air cooperation, and our capability analysis of the Future Combat Air Environment including how manned and unmanned systems might operate together.⁵⁵

...but France switches to Germany

In mid-2017 France and Germany agreed to develop a roadmap by mid-2018 to work on developing a Future Combat Air System.⁵⁶ Both countries are looking to replace their respective Rafale and Typhoon fleets around 2035-2040. At the Berlin Air Show in April 2018, France and Germany signed a High-Level Common Requirement Document for FCAS and Dassault and Airbus, who respectively make Rafale and Typhoon. At the same time, the two companies signed an initial agreement to cooperate on the

⁵² For example, the National Audit Office found the collaborative decision making on the Typhoon was inefficient: "Management of the Typhoon project", National Audit Office, HC 755 2010-2011, 2 March 2011. The 2012 Defence White Paper [National Security through Technology](#) acknowledged the advantages and disadvantages of multilateral collaboration, Cm 8278, February 2012, para 87

⁵³ ["UK-France defence co-operation treaty announced"](#), Ministry of Defence, 2 November 2010

⁵⁴ ["UK strengthens defence partnership with France"](#), Ministry of Defence, 16 December 2016

⁵⁵ [UK-France communique](#), Royal Military Academy Sandhurst, 18 January 2018

⁵⁶ ["France and Germany to develop new European fighter jet"](#), Reuters, 13 July 2017

System.⁵⁷ The French embassy said FCAS will “revolve around a piloted component, missiles, highly-connected drones able to act either autonomously or within a system of systems” and published a list of requirements, including air-to-air and air-to-surface missions, act in disputed airspace and, for the French, be navalised.⁵⁸

France was originally part of the Eurofighter consortium but left to develop the Rafale aircraft. RUSI’s combat aviation analyst Justin Brock notes that while France and Germany have compelling reasons to cooperate on developing a new combat aircraft, there is considerable potential for friction in terms of requirements-setting and design priorities.⁵⁹

So where does this leave the UK?

The Government says the UK and France will continue to collaborate on combat air system technologies.⁶⁰

Reuters has suggested “most defence experts believe the UK will eventually be invited to join the (French/German) programme”.⁶¹ BAE have said they are “absolutely convinced” that the UK, BAE Systems, will be involved, although Airbus’ Dirk Hoke was less sure, saying that in the near-term decisions had to be made “whether to include or exclude the UK in certain projects depending on how Brexit will progress. If it’s a hard Brexit, it will be a very difficult decision”.⁶²

That said, RUSI analyst Justin Bronk downplays the importance of Brexit, arguing instead the key drivers for side-lining the UK from the France/Germany agreement are the huge F-35 commitment and pressures on the UK defence budget. Bronk points out there is unlikely to be room in the equipment programme for the UK to be sufficiently involved in the development and procurement of a new European fighter aircraft during the 2020s.⁶³ Indeed, Malcolm Chalmers, a defence economist at RUSI, has suggested the MOD might slow down the pace of F-35 orders to alleviate pressure on the defence budget in the 2020s.⁶⁴

The French defence ministry has suggested working with Germany on FCAS, which they call SCAF, is their priority. An unofficial translation of the French press release states:

In parallel, we will continue Franco-British work that is complementary to the Franco-German approach and we will see,

⁵⁷ [“Airbus, Dassault to team up for new fighter jet project”](#), Reuters, 25 April 2018

⁵⁸ [“FCAS / MALE / MAWS: Advances in Franco-German Cooperation on Capabilities”](#), French Armed forces Ministry press released translated by defence-aerospace.com, 26 April 2018

⁵⁹ Justin Brock [“UK prospects for the new Franco-German fighter”](#), RUSI Commentary, 31 July 2017

⁶⁰ “National Security Capability Review, March 2018, para 8

⁶¹ [“Germany, France agree main needs of new joint fighter program”](#), Reuters, 24 April 2018

⁶² [“Fears Britain could be frozen out of new European fighter project”](#), Daily Telegraph, 25 April 2018

⁶³ Justin Brock [“UK prospects for the new Franco-German fighter”](#), RUSI Commentary, 31 July 2017

⁶⁴ Malcolm Chalmers, “Decision Time: the national security capability review 2017-18 and defence”, RUSI Whitehall Report 1-18, February 2018

22 Prospects for combat air: What follows Typhoon and Lightning?

when they have reached a sufficient maturity, the terms of integration into the SCAF project. All this will have to be negotiated with our partners.⁶⁵

Gavin Williamson strongly hinted the UK is not confining itself to France and Germany. Calling on the combat air strategy to be ambitious and imaginative, the Defence Secretary said:

That means exploring all the options, not just thinking about collaborating with traditional partners such as France or Germany but turning to new markets and seeking out opportunities as they open up.⁶⁶

One consideration for the UK is the mechanism by which France and Germany choose to take forward their work. The new EU mechanism for defence, PESCO, is expected to adopt the next set of projects in late 2018. Could France and Germany opt to take forward work on SCAF under the umbrella of PESCO? The UK is not a member of PESCO and although it could participate in a project as a third party, it has no powers or voting rights over current projects or its future strategic direction.⁶⁷

⁶⁵ [“FCAS / MALE / MAWS: Advances in Franco-German Cooperation on Capabilities”](#), unofficial translation of French armed forces ministry press release via defence-aerospace.com, 26 April 2018

⁶⁶ “Britain must rediscover its bulldog spirit”, Gavin Williamson, Daily Telegraph, 8 May 2018

⁶⁷ For more see Commons Library briefing papers [“EU defence: the realisation of Permanent Structured Cooperation \(PESCO\)”](#), CBP8149, and [“European defence: where is it heading?”](#), CBP8216, both published 2 May 2018.

10. A single platform or a system of systems?

While the need for a Combat Air Strategy is driven in part by thinking about what will replace Typhoon from 2040, it does not necessarily follow that what will result will be a single platform. So, unlike the National Shipbuilding Strategy, which focused heavily on the initial need for new frigates and longer-term on replacements for other vessels, the Combat Air Strategy may instead scope out the alternative or additional ways defence can fulfil the requirements of combat air that are not confined to the traditional combat aircraft model.

The proposed Airbus/Dassault Future Combat Air System, for example, is more than just an individual combat aircraft. Rather, it is a “system of systems” which will be connected and work together and is expected to include a next generation fighter aircraft, unmanned aerial vehicles (both medium-altitude long-endurance aerial vehicles and swarm drones), future cruise missiles, connectivity and secure communications.⁶⁸

Fourth, fifth or sixth generation?

Discussion of future aircraft sometimes uses the term ‘sixth generation’. To put this into context, Tornado is a fourth generation and Lightning a fifth-generation aircraft. Typhoon sits between the two. The following analysis is helpful:

While the fifth-generation looks to roll-out the latest technologies and the fourth-generation looks to keep up, manufacturers are now beginning to turn their attentions to the sixth generation...

While the design parameters of such futuristic aircraft are still in their conceptual stages, most analysts agree that while fifth-generation is largely defined by stealth, so sixth-generation will itself be defined mainly in terms of being optionally manned.

With these development plans still in their early stages, it has yet to be clearly defined as to whether these sixth-generation efforts will result in entirely new platforms, or whether they will instead be focused on developing new technologies in fields such as propulsion, sensors, airframes, weapon systems (including lasers) and the like.

Whatever the future holds for the development of fourth-, fifth-, and even sixth-generation aircraft, it is all dependent on financing, and in the West at least, money for such projects continues to be in short supply.⁶⁹

Lockheed Martin, describing its own F-35 as “already 10 to 15 years ahead of peer adversaries”, told the Defence Committee that a sixth-generation platform “will only become necessary when a technology is developed which cannot be incorporated into existing platforms”. The company suggested the strategy “should also make targeted investments in

⁶⁸ [“Airbus and Dassault Aviation join forces on Future Combat Air System”](#), Airbus, 25 April 2018

⁶⁹ “Beyond the Raptor and Lightning II: World plays fifth-generation catch-up”, Jane’s International Defence Review, 24 August 2016.

24 Prospects for combat air: What follows Typhoon and Lightning?

disruptive technologies that could “trigger” the need for a ‘Sixth-Generation’ programme”.⁷⁰

⁷⁰ [Lockheed Martin UK written evidence to The Modernising Defence Programme](#), Defence Committee, 24 April 2017, MDP0025

11. Flight Training

The Defence Equipment Plan 2017 includes within the Combat Air allocation spending on military flying training. This includes “new aircraft systems and synthetic training environments to enhance delivery of trained aviators until 2033.”⁷¹

Military flight training is provided by Ascent Flight Training, which was contracted in 2008 to deliver and manage military flight training for all three services until 2033. This is known as the UK Military Flying Training System (UKMFTS). Ascent is a joint venture between Lockheed Martin and Babcock International.

The MOD placed a £1.1bn contract in 2016 with Ascent for Fixed Wing Flying until 2033. The training includes enhanced synthetic and live flying training. A £500m sub-contract was placed with Affinity, which is a joint venture between Elbit Systems (UK) and Kellogg Brown and Root Ltd.⁷²

⁷¹ [The Defence Equipment Plan 2017](#), 31 January 2018

⁷² [HCWS502](#), 2 February 2016; “[£1.bn investment by MOD in future military flying training](#)”, Ministry of Defence, 2 February 2016

12.A defence space strategy?

A deepening row over the UK's access to a new EU global navigation system, Galileo, after Brexit has implications for the UK armed forces and UK defence.

Galileo is the European Union's Global Satellite Navigation System. The UK is contributing to its development and it is expected to be fully operational by 2020.⁷³ Galileo will provide the EU with a satellite navigation system that is independent of America's Global Positioning System (GPS). Russia and China have also developed their own indigenous systems. RUSI analyst Alexandra Stickings points out that it is possible that system operators could degrade or deny the signals on which others rely – hence the need for sovereign global satellite navigation systems.⁷⁴

Brexit could bring the UK's involvement in Galileo to an end. This has implications for defence because the armed forces were due to have access to the encrypted system when it is fully operational.⁷⁵

The UK is threatening to walk away from Galileo if it cannot reach agreement with the EU about continued UK participation; full and continued access to the Public Regulated Service (PRS), which is an encrypted service environment only available to EU Member States, and for UK entities to compete for PRS-related contracts; and codify trust between the UK and EU, enabling the protection and exchange of sensitive security-related information relating to PRS.

The Government says limiting UK access to 'user status' "would not meet the UK strategic security requirements and would not provide the basis for continued UK collaboration in Galileo".⁷⁶ Greg Clark, the Business Secretary, warned EU Member States in April that "without continued access to security-related information, the UK could be obliged to end its participation in Galileo".⁷⁷

The Government has described the arrangements for UK cooperation on Galileo as an "important test case of the depth of operational cooperation and information sharing envisaged" under the UK-EU Security Partnership.⁷⁸

Gavin Williamson is bullish about UK opportunities post-Brexit:

Questions over our participation in the Galileo satellite programme are a perfect example of how there is an abundance of opportunity out there. We should not fear or doubt our ability to go it alone or to seek out new partnerships with countries such as Japan, South Korea,

⁷³ The European Commission has overall responsibility for the programme and it is being developed by the European Space Agency. [Galileo](#), European Commission, 9 May 2018

⁷⁴ Alexandra Stickings, "[Brexit in space: will the UK have access to the Galileo satellite network?](#)", RUSI Commentary, 9 April 2018

⁷⁵ "[UK space agency leads work on options for independent satellite system](#)", Gov.uk, 2 May 2018

⁷⁶ "[Framework for the UK-EU Security Partnership](#)", Department for Exiting the European Union, 9 May 2018

⁷⁷ "Britain threatens to quit Galileo satellite project:", Financial Times, 20 April 2018

⁷⁸ "Framework for the UK-EU Security Partnership", Department for Exiting the European Union, 9 May 2018

Australia and others. We have the expertise, the technical know-how and, crucially, the will to succeed.

That's why it is right that our brilliant defence scientists and military experts have started work scoping out the possibilities of developing our own satellite system while we continue talks with the European Commission over our future role in Galileo. And we won't rule out working with other nations.⁷⁹

The UK Space Agency has been tasked with developing options for a British Global Navigation Satellite System.⁸⁰ Defence scientists and military experts are involved in this work. The UK Space Agency will publish a Space Strategy in 2018.⁸¹ Last year the MOD said it is “developing a Defence Space Strategy to consider how we protect and enhance key capabilities, operations, personnel, and international engagement”.⁸²

⁷⁹ Gavin Williamson, “Britain must rediscover its bulldog spirit: Let’s not be cowed by Europe over the Galileo satellite programme: we can build our own version”, Daily Telegraph, 8 May 2018

⁸⁰ [“UK space agency leads work on options for independent satellite system”](#), Gov.uk, 2 May 2018

⁸¹ National Security Capabilities Review, p29

⁸² Ministry of Defence Annual Report and Accounts 2016-17, HC 21, 19 July 2017, p38

About the Library

The House of Commons Library research service provides MPs and their staff with the impartial briefing and evidence base they need to do their work in scrutinising Government, proposing legislation, and supporting constituents.

As well as providing MPs with a confidential service we publish open briefing papers, which are available on the Parliament website.

Every effort is made to ensure that the information contained in these publicly available research briefings is correct at the time of publication. Readers should be aware however that briefings are not necessarily updated or otherwise amended to reflect subsequent changes.

If you have any comments on our briefings please email papers@parliament.uk. Authors are available to discuss the content of this briefing only with Members and their staff.

If you have any general questions about the work of the House of Commons you can email hcenquiries@parliament.uk.

Disclaimer

This information is provided to Members of Parliament in support of their parliamentary duties. It is a general briefing only and should not be relied on as a substitute for specific advice. The House of Commons or the author(s) shall not be liable for any errors or omissions, or for any loss or damage of any kind arising from its use, and may remove, vary or amend any information at any time without prior notice.

The House of Commons accepts no responsibility for any references or links to, or the content of, information maintained by third parties. This information is provided subject to the [conditions of the Open Parliament Licence](#).