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Center for Strategic and Budgetary Assessments

TOWARDS A TIER ONE ROYAL AIR FORCE



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ABOUT THE CENTER FOR STRATEGIC AND BUDGETARY ASSESSMENTS (CSBA)

The Center for Strategic and Budgetary Assessments is an independent, nonpartisan policy research institute established to promote innovative thinking and debate about national security strategy and investment options. CSBA's analysis focuses on key questions related to existing and emerging threats to U.S. national security, and its goal is to enable policymakers to make informed decisions on matters of strategy, security policy, and resource allocation.

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Cover: U.S. Air Force F-35A Lightning II Joint Strike Fighters perform an aerial refuelling mission, May 16, 2013, off the coast of Northwest Florida. U.S. Air Force photo by Master Sgt. Donald R. Allen. An Australian Air Force E-737 Wedgetail returns to the exercise after receiving fuel, June 20, 2012, during Red Flag-Alaska 12-2. Department of Defense photo by U.S. Air Force Tech. Sgt. Michael R. Holzworth. Photo by Vladimir Korolkov of an RAF Eurofighter Typhoon at Farnborough in 2010.

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Executive Summary

Countering transnational terrorism was the predominant challenge for many of the world's Western militaries for nearly 15 years after the September 11, 2001 terrorist attacks on the United States. This focus is beginning to change as tensions grow between the West and the revisionist governments of Russia and China. The United Kingdom's *2018 National Security Capability Review* and the United States' *2018 National Defense Strategy* both acknowledge the need to shift towards deterring great power aggression.¹ This shift does not diminish the dangers posed by transnational terrorism and other potential threats to stability in the Middle East, Europe, and other regions. Rather, it is an acknowledgement that, in addition to acts of terrorism committed by violent extremist groups, the United Kingdom and United States are confronted with an increasingly complex security environment that includes the threat of great power aggression, rogue states equipped with guided missiles and other modern weapons, and conflict in cyberspace.

Since the end of the Cold War, there has been a substantial disconnect between the United Kingdom's *National Security Objectives* and the resources provided to the Ministry of Defence (MoD) to achieve them. In the early 1990s, cuts to the UK military budget and reductions in its force structure were rationalised by arguments that the world was a safer place in which most challenges to the nation's security interests could be addressed in a time and manner of its choosing by a smaller Joint Force. Years of these cuts resulted in a military that is much diminished and lacks the degree of resilience that may be needed in a conflict with Russia or another great power. Moreover, the assumed post-Cold War decrease in operational demand for military forces never really materialised. Since 1991, UK forces have been deployed to the Middle East, Afghanistan, and Eastern Europe on a persistent basis even as national defence spending decreased. This helped to create a decades-long mismatch between the missions the UK military has been required to support and the resources made available to it.

1 HM Government Cabinet Office, *National Security Capability Review* (United Kingdom: Ministry of Defence [MoD], 2018); and U.S. Department of Defense (DoD), *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge* (Washington, DC: DoD, January 2018).

Should the United Kingdom fail to align its resource priorities with its changing national security needs, this mismatch will grow even larger. As the United Kingdom and much of the Western world focused on improving their militaries for counter-terror operations, Russia and China were preparing for high-end, state-on-state conflict. Other potential state and non-state adversaries have taken advantage of the proliferation of technologically advanced weapon systems to improve their ability to counter how Western militaries have preferred to project power. Consequently, some military advantages the United Kingdom have become accustomed to, such as the nearly unchallenged ability to gain air dominance and strike with precision, are now being eroded. Understanding how the Joint Force should be sized and shaped for operating environments that will be far more contested in the future than in the past would be a significant step towards checking this erosion.

This report focuses on challenges the Royal Air Force should address as it develops its future plans and resource priorities. Chapter 1 begins by summarising major shifts in the security environment that should inform the RAF's planning. Chapter 2 traces major fiscal, force structure, and security trends that have shaped the RAF since the end of the Cold War. Chapter 3 provides insights from a 2018 Strategic Choices Exercise coordinated by CSBA that tasked defence planners from the United Kingdom to assess alternative future RAF force structures that might be possible given different ten-year funding profiles. Chapter 4 concludes by recommending a force planning construct that could provide a foundation for the RAF's future force development.

Major Insights from a 2018 Strategic Choices Exercise

Strategic Choices Exercises provide a framework for defence strategists, planners, operational experts, and budgeteers to collaboratively assess alternative strategies for a military service, a joint force, or a national defence organisation. Three teams consisting of UK defence experts from different career fields participated in a 2018 Strategic Choices Exercise to assess alternatives to the RAF's planned forces and modernisation programmes over a ten-year period (2019–2028). These teams identified four critical operational challenges that should be the focus of the Service's planning:

- Continued high operational tempo is eroding the RAF's current and future readiness. The RAF has insufficient resources to meet current operational requirements, maintain a sufficient level of readiness to respond quickly to a major security crisis, and modernise to prepare for future challenges.
- Absence of operational sanctuaries. Military bases in the UK homeland are not safe from non-kinetic attacks and air and missile strikes that could be launched by a great power adversary. The RAF's overseas bases and forces are also vulnerable to air and missile attacks, as will be its assets in other operating domains including space, cyberspace, and the electromagnetic spectrum.

- Insufficient mass for emerging challenges. The RAF has insufficient “mass”—aircraft, munitions, and other capabilities—to provide a credible contribution to fight a major conflict with a great power, for instance within a NATO Article V scenario. To cite several examples, the RAF cannot concentrate enough strike weapons in the time and space necessary to overcome Russia’s advanced air and missile defences, and it lacks sufficient reserves of aircraft, aircrew, and aircraft maintainers to sustain combat operations for an extended period of time and to offset combat losses.
- Anti-access/area-denial (A2/AD) complexes will challenge the RAF’s existing operational concepts. The emergence of A2/AD complexes threaten the RAF’s ability to perform core missions such as precision strike and close support for friendly troops in contact with an enemy. Cruise and ballistic missile attacks and other threats could force RAF aircraft to operate further from the battlespace, reducing their sortie rates and the RAF’s ability to concentrate mass at range. Advanced integrated air defence systems (IADS) could prevent the RAF’s non-stealth ISR and strike aircraft from conducting high tempo surveillance operations and attacks on enemy forces. Overcoming these and other A2/AD challenges will require the RAF to field stealth aircraft capable of penetrating contested areas, more survivable extended-range advanced munitions, integrated and fused mission systems to ensure its freedom of action in the electromagnetic spectrum, and the ability to conduct ISR in a contested environment.

Recommendations

The 2018 RAF Strategic Choices Exercise also tasked teams to identify opportunities to better prepare the Service to counter emerging threats and close existing gaps between its resources and operational commitments. The following recommendations derived from this exercise would require moderate increases in the RAF’s budget and the development of new concepts and capabilities for air operations in future threat environments.

The RAF has an Opportunity to Become a Counter-A2/AD Force of Choice

The continued maturation of Russia’s and China’s A2/AD complexes and the proliferation of modern military technologies to hostile states and non-state actors will further shrink the margin between what has traditionally been considered as either permissive or contested operating environments. To remain a force capable of meeting the nation’s security commitments, the RAF should plan to operate in future environments that will be increasingly contested *regardless* of the nature and size of the conflict. Transitioning to a force capable of countering A2/AD threats would bolster NATO’s deterrent posture and help address many of its most pressing capability shortfalls. This would, furthermore, provide the United Kingdom with the opportunity to maintain its favoured position as the partner of choice for the United States. The following are representative of initiatives that would help the RAF to become a counter-A2/AD force of choice:

- Increase the RAF's capacity to strike with precision over long ranges and into contested areas by procuring F-35A fighters while maintaining the current F-35B acquisition objective;
- Develop and field hypersonic weapons and other advanced munitions that are more capable of surviving in contested environments and attacking challenging targets such as SAM systems and missile launchers that can quickly relocate;
- Take advantage of improvements in unmanned systems technologies to field new multi-mission unmanned aircraft, including low-cost attritable systems that can team with manned aircraft;
- Procure active and passive (e.g., camouflage, decoys, aircraft shelters) defences against air and missile attacks to defend the homeland and improve the resilience of the RAF's expeditionary bases;
- Increase the coverage, endurance, and resilience of the RAF's airborne and space-based ISR networks and fusion capabilities to support homeland defence and future power projection operations in contested environments.

The RAF Should Plan for Great Power Competition and Conflict

From a strategic perspective, the return of great power competition has closed the window of time where the RAF could easily accept risk by forgoing investments needed to rebuild its readiness and modernise its forces. The RAF should use realistic scenarios for great power conflicts to assess its future capability and force structure capacity requirements. These scenarios should address Russia's evolving military strategy and its A2/AD weapon systems that are designed to prevent timely NATO military responses to Russian aggression and deny NATO's freedom of action in all operating domains. The capabilities needed to operate in this environment will apply across several future scenarios, where the proliferation of modern technologies will demand the same capabilities.

The RAF Should Prepare to Defeat Aggression in the Grey Zone

Given Russia's and China's recent acts of grey zone aggression in their respective regions, RAF military planners should not assume that they will forgo similar activities in the future.² Russia's successful military operations in Georgia, Crimea, and eastern Ukraine could encourage it to conduct similar actions against one or more of the Baltic states. Unlike the case

2 U.S. defence analysts have described grey zone actions as part of an "intense political, economic, informational, and military competition more fervent in nature than normal steady-state diplomacy, yet short of conventional war." Joseph L. Votel, Charles T. Cleveland, Charles T. Connett, and Will Irwin, "Unconventional Warfare in the Gray Zone," *Joint Forces Quarterly* 80, 1st quarter, 2016, p. 102. Russia's and China's military strategies incorporate peacetime non-military diplomatic, information, and economic actions with low-intensity gray zone military operations and high-end military capabilities to gain influence and territory without having to escalate to a major conflict.

of Georgia and Ukraine, however, Russian aggression in the Baltics—grey zone or otherwise—could lead to a large-scale NATO military response. A future RAF with sufficient forces and capabilities to deny Russia’s use of its A2/AD “umbrellas” over the Baltic Sea and Black Sea regions would help NATO to deter these acts.

Develop a New Force Planning Construct to Guide the RAF’s Future Planning

Force planning constructs articulate critical planning assumptions, operational concepts, and key scenarios that help guide future military modernisation and translate a defence strategy into resource priorities.³ In addition to supporting homeland defence and the United Kingdom’s at-sea strategic nuclear deterrent, a force planning construct should size and shape the RAF to make a meaningful contribution to a major NATO Article V operation to defeat Russian aggression in Eastern Europe. This should result in a force that also has the capacity to conduct sustained counter-terrorism operations and other lesser missions.⁴ The RAF’s next force planning construct should be informed by new operational concepts and emerging technologies that will help increase its lethality, survivability, and readiness to operate in contested environments.

3 For more on force planning constructs, see Mark Gunzinger, *Shaping America’s Future Military: Toward a New Force Planning Construct* (Washington, DC: Center for Strategic and Budgetary Assessments, 2013); and Mark Gunzinger, Bryan Clark, David E. Johnson, and Jesse Sloman, *Force Planning for the Era of Great Power Competition* (Washington, DC: Center for Strategic and Budgetary Assessments, 2017).

4 There may be some exceptions to this. For instance, counter-terror operations could create an additional demand for some specialised RAF capabilities.

CHAPTER 1

Informing the RAF's Future Planning: Major Strategic Shifts

The end of the Cold War initiated a period of substantial change for the security planning of the United Kingdom. The collapse of the Soviet Union eliminated the primary challenge the Ministry of Defence and its Services used as a foundation for determining their future force structure and capability requirements. Over a series of defence reviews, a post-Cold War UK military emerged that was substantially smaller than its predecessor, albeit still well trained, well equipped, and capable of supporting NATO and national defence missions.⁵ As the threat of a global nuclear confrontation diminished, the UK MoD, similar to the U.S. Department of Defense (DoD) and other NATO allies, cut the size of its forces and implemented efficiency initiatives to generate savings. This eliminated duplicative capabilities across the United Kingdom's military Services, created increasingly lean organisational and command structures, and transitioned some capabilities to the private sector to support the delivery of certain missions.⁶ The MoD also prioritised the acquisition of capabilities needed for peacekeeping and stability operations, combatting international terrorism, and other asymmetric threats, partially at the expense of modernising its forces for great power conflict.

If the United Kingdom's decline in defence spending had coincided with reduced operational demands on its military, force cuts and efficiency measures mandated by its post-Cold War defence reviews may have been sustainable. In reality, long-running commitments to operations in Iraq, Afghanistan, the Baltic Sea region, and elsewhere severely stretched the UK

5 For an overview of previous MoD strategic reviews, see Claire Mills, Louisa Brooke-Holland, and Nigel Walker, *A Brief Guide to Previous British Defence Reviews* (London: House of Commons Library, 2018).

6 For instance, all MoD helicopters were consolidated in a Joint Helicopter Command, the service-specific logistics organisations were consolidated into one joint-organisation, and the RAF entered a commercial arrangement via a Public Finance Initiative (PFI) whereby aerial refuelling platforms are commercially owned and operated by the RAF.

military in general and the RAF in particular.⁷ Today, the global security environment is far more dangerous than at any time since the height of the Cold War. Moreover, it is likely that demands for the United Kingdom’s military will increase and shift towards deterring great power aggression, even as counter-terrorism remains an enduring mission that taxes its readiness. These trends are increasing the gap that already exists between the United Kingdom’s security priorities and the capabilities and capacity of its military to support them. The remainder of Chapter 1 is a brief assessment of major changes in the security environment that should be considered by the MoD and RAF as they develop their future force planning priorities.⁸

The Return of Great Power Competition

Almost thirty years after the Cold War, Russia’s aggression against Eastern Europe’s “front-line” states and China’s expansionist actions in the East and South China Seas signal the return of great power competition. Russia and China both seek to shape regional and international norms in their favour, in part by undermining Western influence in their respective regions. This presents major challenges not only to the security of the United Kingdom and its allies, but also to the stability of the international system.⁹

On the European continent, a revisionist Russian government is determined to regain Russia’s great power status by dominating former Soviet and Warsaw Pact states and, ultimately, discrediting NATO. Although Russia’s desire to re-establish a sphere of influence and security buffer against NATO on its western flank is not new, the past decade has seen a marked increase in both the intensity of what it perceives as encroachments on its “territory” and its willingness to use its military, economic, information, and other elements of national power to achieve its objectives. Russia’s annexation of Crimea and subsequent invasion of eastern Ukraine undermined longstanding security norms and precipitated the most serious European security crisis since the 1990s Balkans conflict. NATO’s defence posture is losing its credibility given Russia’s demonstrated willingness to use military force to achieve its objectives, its ongoing defence modernisation, and its force overmatch compared to NATO’s frontline states.¹⁰ To reverse this trend, the United Kingdom and its NATO allies should shift their defence planning and resource priorities towards creating a future allied force that collectively will be capable of deterring and, if necessary, defeating Russian aggression.

7 Chapter 2 expands on these force structure and deployment trends.

8 For more comprehensive analyses on these trends, see Andrew F. Krepinevich, *Preserving the Balance: A U.S. Eurasia Defense Strategy* (Washington, DC: Center for Strategic and Budgetary Assessments, 2017); and Hal Brands and Eric S. Edelman, *Why is the World So Unsettled? The End of the Post-Cold War Era and the Crisis of Global Order* (Washington, DC: Center for Strategic and Budgetary Assessments, 2017).

9 Brands and Edelman, *Why is the World So Unsettled?* pp. 11–15.

10 See, for example, David A. Shlapak and Michael Johnson, “Outnumbered, Outranged, and Outgunned: How Russia Defeats NATO,” *War on the Rocks*, April 21, 2016; and Richard Connolly and Mathieu Boulègue, *Russia’s New State Armament Programme: Implications for the Russian Armed Forces and Military Capabilities to 2027* (London: Chatham House, 2018).

Whereas Russia may pose the more immediate security threat to the United Kingdom, China's flaunting of international norms and its efforts to present its political and economic model as a viable alternative to liberal democracy also pose challenges to the United Kingdom's enduring values and interests. China's ambitions include extending its influence and control over disputed areas in the South China Sea, eroding confidence in the United States as a security guarantor in the Indo-Pacific region, and eventually establishing itself as the dominant regional power.¹¹ China's willingness to use its growing economic and military might to compete with the United States and its allies presents a multi-faceted challenge to the stability and security of the Indo-Pacific region.¹²

Russia's and China's Shift towards Information Warfare

To achieve their revisionist objectives, Russia and China have expanded their core military strategies to include the conduct of forms of information warfare. Unlike large-scale, industrial age warfare, which seeks to induce an enemy's collapse by destroying its economic and military potential to fight, a primary objective of information warfare is to influence an adversary's decision-making at all levels.¹³ Information warfare seeks to achieve victory either by convincing an adversary's leadership not to fight or by wreaking such havoc on an adversary's ability to process and act on information that its operations are ineffective. Russia and China's information strategies include actions in peacetime that are designed to achieve their national security objectives. Traditionally, Western defence planners have treated peacetime competition and conflict as two distinct conditions, whereas Russia and China treat peacetime competition and conflict as two points along the same continuum directed towards a common end. Both are now conducting political warfare and other forms of grey zone aggression that are designed to achieve their strategic objectives without exceeding a level of violence that could instigate military interventions by foreign powers.¹⁴

Although Russia and China's strategies evolved within unique contexts and emphasise the use of a different mix of capabilities, they both prioritise manipulating information to achieve their desired ends. Russia's evolving strategy, referred to by Russian military theorists as "New Type

11 Office of the Secretary of Defense (OSD), *Military and Security Developments Involving the People's Republic of China 2017*, Annual Report to Congress (Washington, DC: DoD, May 15, 2017), pp. i–ii; and DoD, *Summary of the 2018 National Defense Strategy*, p. 2. Although the weight of Chinese ambitions falls in the Indo-Pacific region, China is also extending its influence into Europe. The European Union Commissioner, Johannes Hahn, fears that China could turn countries in the Western Balkans into "Trojan horses" that could one day gain influence within the European Union. See Ryan Heath and Andrew Gray, "Beware Chinese Trojan Horses in the Balkans, EU Warns," *Politico*, July 27, 2018.

12 The White House, *National Security Strategy of the United States of America* (Washington, DC: The White House, December 2017), p. 46.

13 Fan Gaoming, "Public Opinion Warfare, Psychological Warfare, and Legal Warfare: The Three Major Combat Methods to Rapidly Achieving Victory in War," *Global Times* [Chinese], March 8, 2005, as cited in Dean Cheng, *Cyber Dragon: Inside China's Information Warfare and Cyber Operations* (Santa Barbara, CA: Praeger, 2017), p. 262.

14 For more on China's non-military coercive actions see Thomas G. Mahnken, Ross Babbage, and Toshi Yoshihara, *Countering Comprehensive Coercion: Competitive Strategies against Authoritarian Political Warfare* (Washington, DC: Center for Strategic and Budgetary Assessments, 2018).

Warfare,” uses informational, political, economic, and technological actions to seize information superiority and paralyse an adversary’s political and economic systems to “neutralise an adversary’s military superiority.”¹⁵ New Type Warfare includes activities in peacetime that are aimed at “influenc[ing] the perception and behaviour of the enemy, population, and international community on all levels,” and incapacitating “a state as much as possible before that state is even aware that a conflict has started.”¹⁶ Russia views information warfare as one means to defeat “an enemy’s armed forces (and the capture of his territory, destruction of his economic potential, and overthrow of his political system).”¹⁷

China’s information warfighting strategy calls for using kinetic and non-kinetic capabilities in all operational domains to shape an adversary’s decision-making at the strategic, operational, and tactical levels. It is “an asymmetric way to weaken an adversary’s ability to acquire, transmit, process, and use information during war and to force an adversary to capitulate before the onset of conflict.”¹⁸ China’s People’s Liberation Army (PLA) believes that achieving information dominance should be its main operational line of effort in a conflict, and it is reshaping its doctrine, organisations, and capabilities to achieve this dominance.¹⁹

Information warfare is more than a theoretical warfighting strategy. Russia and China have both combined non-military diplomatic, information, and economic actions with low-intensity military/paramilitary operations to gain influence and control over their targeted areas while avoiding full-scale conflict with a major military power or coalition. Russia has used its military, paramilitary, and irregular forces combined with information and political warfare to destabilise Georgia and Ukraine over the last decade and deter them from strengthening their ties with Western institutions. Similarly, China has achieved a near *fait accompli* in the South China Sea by building artificial islands, deploying military forces, and conducting other grey zone actions to gain control over its expansive maritime claims.²⁰

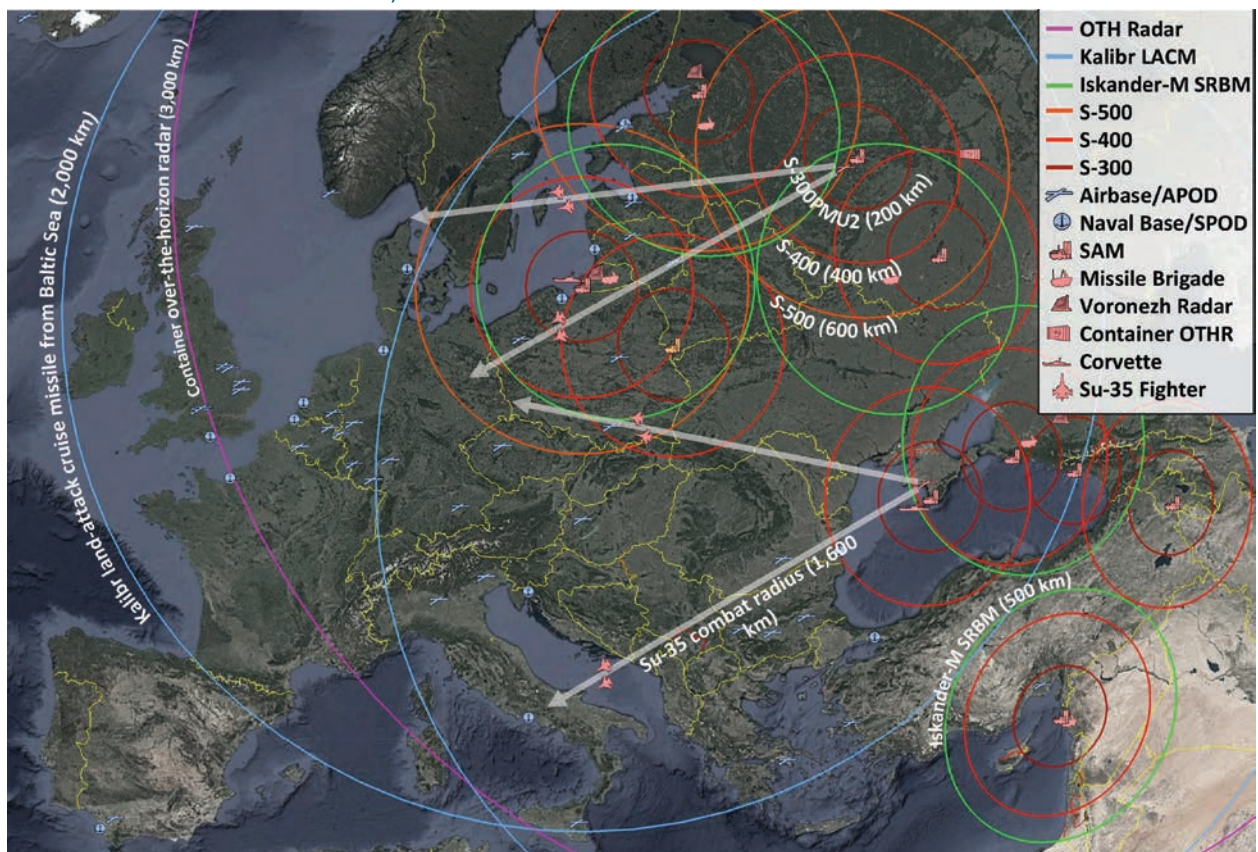
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- 15 For a discussion of New Type Warfare, see Timothy Thomas, “The Evolving Nature of Russia’s Way of War,” *Military Review*, July–August 2017, available at <https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/July-August-2017/Thomas-Russias-Way-of-War/>. For a summary of current Russian strategic thought, see Dmitry (Dima) Adamsky, *Cross-Domain Coercion: The Current Russian Art of Strategy* (Paris: French Institute of International Relations Security Studies Center, November 2015), pp. 23–24.
- 16 A. J. C. Selhorst, “Russia’s Perception Warfare,” *Military Spectator* 185, no. 4, 2016, p. 151, as cited in Keir Giles, *Handbook of Russian Information Warfare* (Rome: NATO Defense College, 2016), p. 6.
- 17 V. Slipchenko, “Информационный ресурс и информационное противоборство [Information Resources and Information Confrontation]” *Armeyskiy sbornik*, October 2013, pp. 52, 151, as cited in Giles, *Handbook of Russian Information Warfare*, p. 17.
- 18 OSD, *Military and Security Developments Involving the People’s Republic of China 2017*, p. 58.
- 19 John Costello, “The Strategic Support Force: China’s Information Warfare Service,” *China Brief* 16, no. 3, February 8, 2016, available at https://jamestown.org/wp-content/uploads/2016/09/CB_Logo.jpg?x87069. See also Joel Wuthrow and Phillip Saunders, *Chinese Military Reforms in the Age of Xi Jinping: Drivers, Challenges and Implications* (Washington, DC: National Defense University Press, March 2017).
- 20 For more on China’s attempts to exert de facto control in its near-seas region, see Ronald O’Rourke, *China’s Actions in South and East China Seas: Implications for U.S. Interests—Background and Issues for Congress* (Washington, DC: Congressional Research Service, 2018).

Russia's and China's Military Priorities Support their National Strategies

Russian and Chinese information warfare strategies are enabled by A2/AD complexes that use IADS; long-range intelligence, surveillance, and reconnaissance (ISR) and strike capabilities; and other advanced military systems to create an umbrella over target areas on their periphery. These complexes are designed to deter foreign militaries from intervening against Russia's or China's actions and, should war occur, prevent those militaries from projecting enough force in time to stop Russia or China from achieving a *fait accompli*.

Russia's integrated air-, ground-, and sea-based weapon systems located in Kaliningrad, its Western Military District, and Belarus are designed to support potential military operations in the Baltic region. A similar umbrella based in the Southern Military district covers the Black Sea region (see Figure 1).

FIGURE 1: RUSSIAN A2/AD REACH OVER THE BALTIC SEA AND BLACK SEA REGIONS

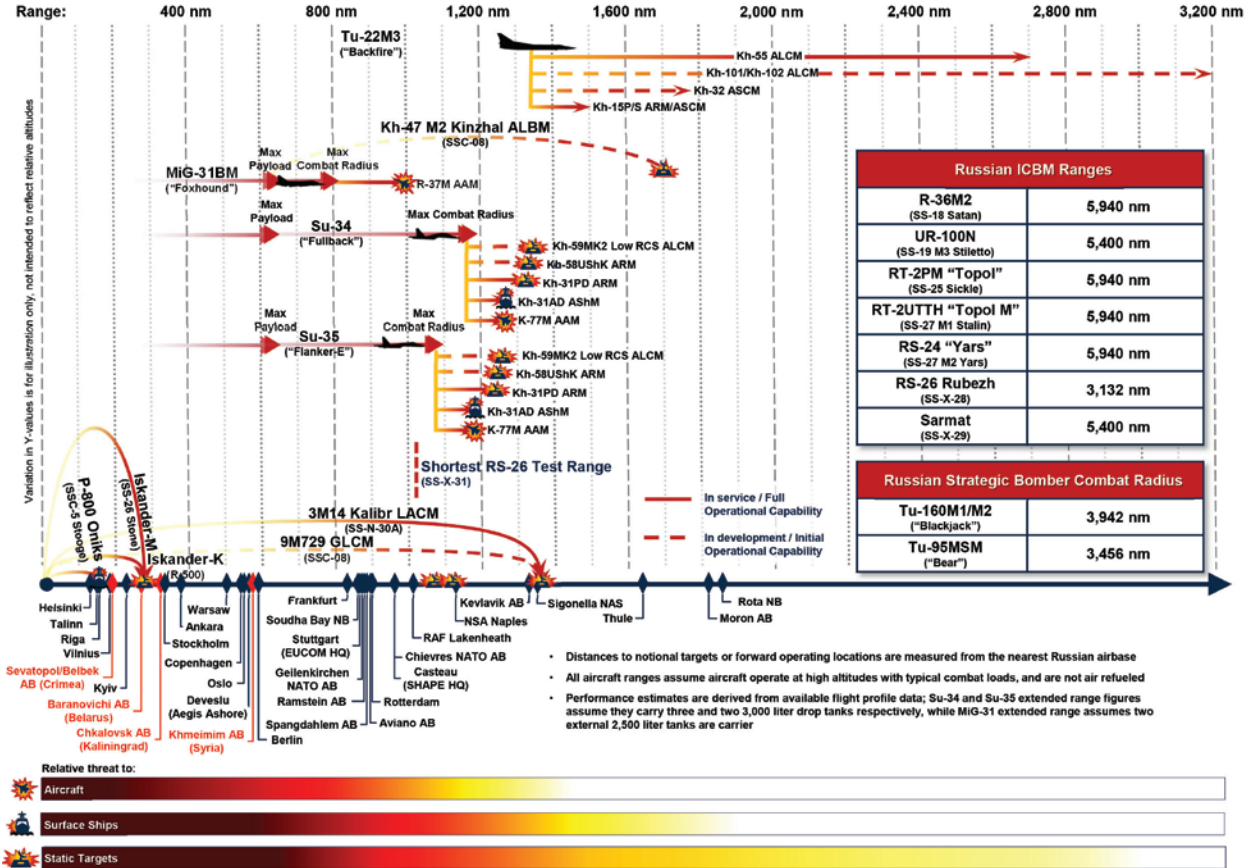


Data to build this graphic derived from IHS Jane's (2019).

If deterrence fails, Russia can employ long-range ISR and strike capabilities to threaten NATO targets throughout Europe. "Rear" areas in Western Europe that NATO has traditionally relied upon to marshal forces arriving on the continent from the United Kingdom and United States,

as well as key allied command, control and communications (C3) hubs located far from the front line, would be vulnerable to Russian missile strikes. Russia’s ground-launched and air-launched missiles can hold targets in the United Kingdom at risk (see Figure 2). There are no operational sanctuaries in and around the homeland, including maritime areas located towards the eastern side of the Greenland-Iceland-United Kingdom (GIUK) gap.²¹

FIGURE 2: RUSSIA'S STRIKE COMPLEX COVERS WESTERN EUROPE

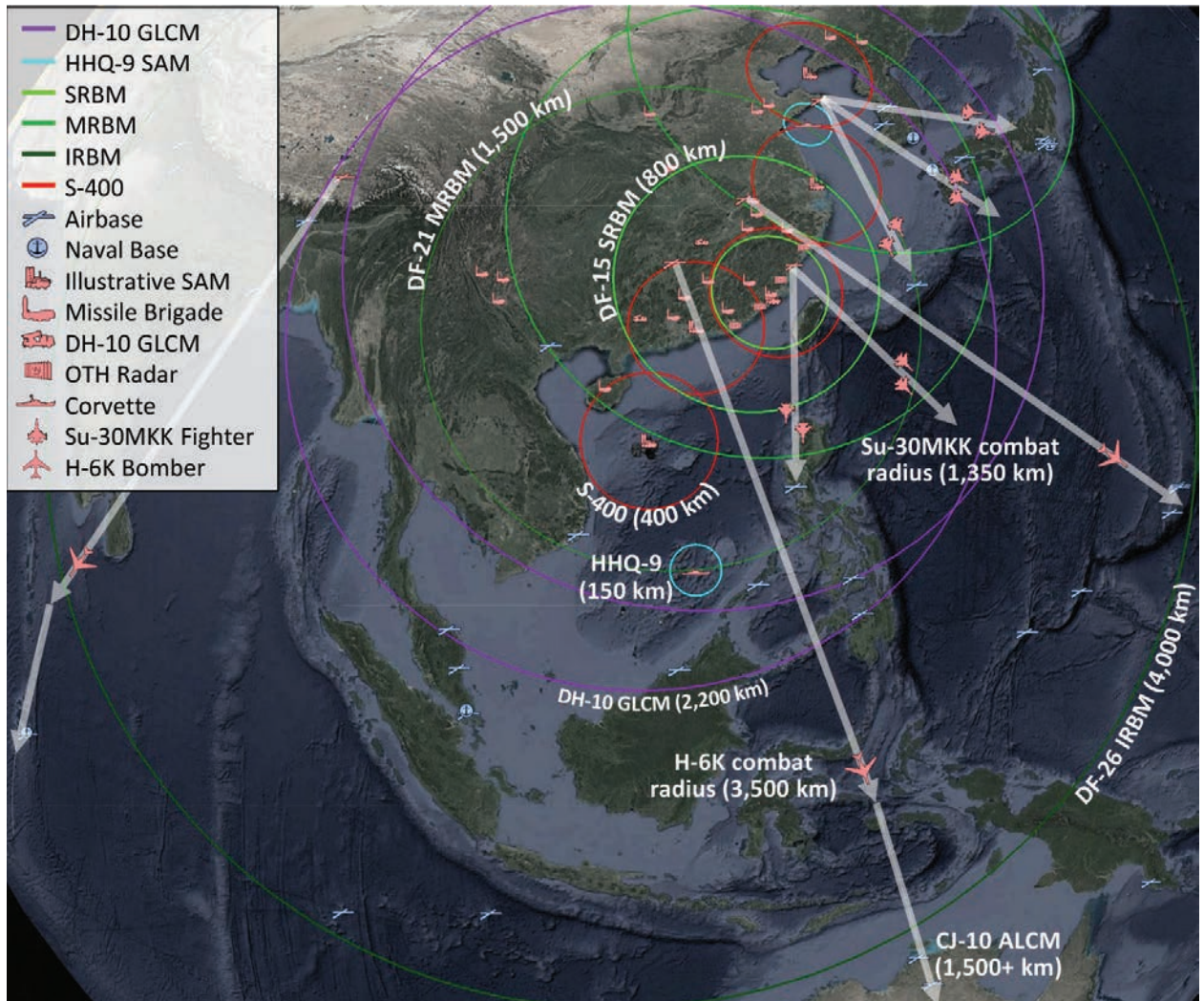


Data to build this graphic was derived from IHS Jane's (2019); National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (2017); and CSIS *Missile Threat* (2019).

China is also increasing the range, precision, and density of its A2/AD capabilities to support its ambitions. China’s militarisation of islands in the South China Sea extends its influence towards critical commercial sea lanes and raises the cost to foreign powers that would seek to roll back China’s military and paramilitary presence in the region.

21 The GIUK gap is a naval chokepoint that was used during the Cold War to prevent Soviet submarines and surface vessels from entering the Atlantic Ocean. Whether via undersea threats or Russian long-range aviation, the GIUK gap is once again being contested.

FIGURE 3: CHINA'S A2/AD COMPLEX EXPANDING PAST THE FIRST ISLAND CHAIN



Data to build this graphic derived from IHS Jane's (2019); and OSD, *Military and Security Developments Involving the People's Republic of China 2018*.

As Russia and China continue to upend the status quo with seeming impunity, they are undermining security assurances made by the United States and United Kingdom to their allies and partners in the Pacific and weakening NATO's ability to deter or prevent aggression against its eastern frontline states.

Rogue States with Modern Weapons

The return of great power competition is not the only security challenge for the MoD and RAF. The proliferation of advanced military technologies has lowered the barrier for rogue states and their proxies to acquire capabilities once held exclusively by top-tier world powers. UK defence planners should consider how the proliferation of unmanned systems, precision-guided munitions (PGMs), ballistic missile technologies, offensive cyber applications, and other means of modern warfare enables rogue states such as Iran to threaten conventional Western military operations. Iranian-supplied weaponry has enabled Hezbollah to function more like a national military in Lebanon and Syria than a non-state militia. These challenges have significant implications for the RAF's future operations and planning. To cite two examples, the RAF should be prepared to a) defend its expeditionary airfields against salvos of guided weapons and long-range artillery and b) counter enemy mobile air defences that contest its freedom of action in the air even absent an adversarial air force.²²

Extremist Terrorist Groups: A Persistent Threat

Seven years after the death of Osama bin Laden, transnational terror groups remain a persistent and evolving threat. Their spread has been fuelled, in part, by instability following the largely unsuccessful Arab Spring movements to overthrow repressive regimes. Although the Islamic State in Iraq and Syria (ISIS) has lost most of its territory, it remains a significant threat. Consequently, it is highly likely that the RAF will continue to be tasked to help suppress the ongoing threat of terrorism in multiple regions as it was for Operation SHADER, the United Kingdom's counter-ISIS air campaign.

The United Kingdom's Alliance Relationships are at an Inflection Point

There was significant strategic and operational alignment between the United Kingdom and its allies and partners during post-Cold War contingency operations such as the 1991 Gulf War, NATO's intervention during the Bosnian War, the Kosovo War, counter-terror operations in Afghanistan, and most recently the campaign against ISIS. More importantly, the United Kingdom and its allies and partners faced most of these challenges in sequence and were able to choose when and how to respond. Given the return of great power competition, the United Kingdom should not assume that it will have the initiative in future crises and may have to respond to defend its national interests without guarantees that intra-alliance interests will continue to align.

22 Jonathan Marcus, "Russia S-400 Syria Missile Deployment Sends Robust Signal," *BBC News*, December 1, 2015.

There are now significant divergences within NATO as to the prioritisation of threats to Europe's stability and security.²³ European frontline states such as Poland, Estonia, Latvia, and Lithuania view Russia as the primary threat to their national security. German and British political leaders have argued that NATO must focus on Russian aggression, and the United Kingdom's 2017 *National Security Capability Review* recognised the resurgence of state-based threats.²⁴ Recent changes to the U.S. national security and defence strategies also have significant implications for Europe's collective security.²⁵ The U.S. *2018 National Defense Strategy* declared that great power competition, not terrorism, should be the primary focus of its national security policy and planning.²⁶ However, others suggest that immigration and a general economic malaise pose a greater challenge to Europe's security.²⁷ Greece, Italy, Portugal, Hungary, and Cyprus do not view Russia as a threat and are more concerned about terrorism and uncontrolled migration.²⁸ Although countering terrorism remains a significant concern for both the United Kingdom and United States, preparing to deter, and if necessary, defeat great power aggression appears to be the predominant challenge that is beginning to drive their defence planning.

Even where strategic priorities continue to overlap, the militaries of European NATO members are, in most cases, hollow shells compared to their stature at the end of the Cold War. For example, in 1991 the German army maintained 7,000 tanks. By 2018, that number had shrunk to 236, of which an even smaller number are now considered fully operational.²⁹ The German tank brigade earmarked for NATO's 2019 Very High Readiness Joint Task Force (VHJTF) has *nine* operational tanks out of a desired 44.³⁰ The situation is not much better for some other European NATO countries.³¹ NATO's stocks of preferred munitions are also greatly diminished relative to its Cold War weapons inventories. Absent emergency purchases,

23 The United Kingdom's pending departure from the European Union could further complicate the alignment of its security priorities with those of its European NATO allies and partners.

24 Janosch Delcker, "Angela Merkel: NATO Must Refocus on Russia Threat," *Politico*, July 9, 2018; and Aaron Mehta, "A 'weakness of the West'? UK defense minister warns of lack of grand strategy," *Defense News*, August 9, 2018. See also HM Government Cabinet Office, *National Security Capability Review* (2018).

25 A recent Pew Research Center survey identified a substantial gap between European NATO members believing that the United States would use military force to defend a NATO ally and that their country should use force to defend a NATO ally. For more, see Moira Fagan, "NATO Is Seen Favorably in Many Member Countries, but Almost Half of Americans Say It Does Too Little," *Pew Research Center*, July 9, 2018.

26 DoD, *Summary of the 2018 National Defense Strategy*, p. 1.

27 Judy Dempsey, "Judy Asks: Is Russia Europe's Biggest Threat," *Carnegie Europe*, February 21, 2018.

28 For more on national threat perceptions, see Susi Dennison, Ulrike Esther Franke, and Pawel Zerka, "The Nightmare of the Dark: The Security Fears that Keep Europeans Awake at Night," *European Council on Foreign Relations*, July 2018.

29 German tank inventories are reported in International Institute for Strategic Studies (IISS), *The Military Balance* (London: Oxford University Press, 1991 and 2018), pp. 59, 108.

30 Ben Knight, "German Military Short on Tanks for NATO Mission," *Deutsche Welle*, February 2, 2018.

31 For more on the decline, relative to potential adversaries, of Western powers see Hal Brands, *Dealing with Allies in Decline: Alliance Management and U.S. Strategy in an Era of Global Power Shifts* (Washington, DC: Center for Strategic and Budgetary Assessments, 2017).

European NATO members would have run out of PGMs during the early stages of their 2011 air campaign over Libya.³² This broad-based decline highlights the inability of many European NATO members to conduct independent military actions without the support of the United States.

Balancing Resources Across Multiple Security Challenges

The United Kingdom is an island nation with many strategic and geographic flanks. As a result, the MoD will need to support enduring requirements to protect the United Kingdom's sea lines of communication, maintain a continuous at-sea deterrent, defend sovereign territories overseas, and remain engaged in the Levant, Afghanistan, and the Sahel. Absent increased investments in high-demand but low-density assets such as ground-based air defences, ISR aircraft, and capabilities to suppress advanced air defences, it may be unable to meet these challenges alone.

Illustrative Force Planning Implications for the RAF

A renewed focus on planning for great power competition. From a strategic perspective, the return of great power competition has closed the window of time where the United Kingdom and its NATO allies could easily accept risk by forgoing investments to modernise and rebuild the capacity and readiness of their militaries. Mass, moreover, has a quality of its own, and the RAF's force structure is too small to support the UK's ongoing operations and remain adequately prepared for the major conflict scenarios described in Chapter 2.³³ Creating a force planning construct that is focused on great power conflict, defence of the homeland, and other priorities could help the RAF to identify and communicate its future force structure needs.³⁴ The candidate construct described in Chapter 4 could guide the RAF's force development planning and resource assessment activities.

Operating in increasingly contested environments. The continued maturation of Russia's and China's A2/AD complexes and the proliferation of modern military technologies to rogue states and non-state actors will further decrease the margin between what has traditionally been considered either permissive or contested operating environments. Consequently, the RAF should plan to conduct operations in future environments that will be increasingly contested in nature regardless of the nature and scale of a conflict.

32 Karen DeYoung and Greg Jaffe, "NATO Runs Short on Some Munitions in Libya," *The Washington Post*, April 25, 2011.

33 Justin Bronk, "The RAF's Force Structure Plan and Future Threat Scenarios," *The RUSI Journal* 163, no. 3, 2018, pp. 52–57. This is not to say the service's capabilities are outmoded; the RAF has a formidable mix of weapon systems to confront threats posed by Russia and lesser non-state threats as demonstrated by its air operations against ISIS.

34 A force planning construct defines the scenarios and missions a military or service should be sized and shaped to accomplish. It guides the translation of a defense strategy to resourcing decisions.

Engaging grey zone aggressors. Given Russia's and China's recent actions in their respective regions, RAF military planners should not assume that they will forgo similar grey zone activities in the future. Russia's successful military operations in Georgia, Crimea, and eastern Ukraine could encourage it to conduct similar actions against one or more of the Baltic States. Unlike the case of Georgia and Ukraine, however, Russian aggression in the Baltics—grey zone or otherwise—could lead to a large-scale NATO military response.

Summary

These strategic and operational shifts should inform MoD and RAF requirements for new concepts, forces, and capabilities to defend the homeland and project military power in the future. Creating new scenarios for forms of information warfare would help create a baseline for planners to assess these requirements. The RAF's planning scenarios should address Russia's evolving military strategy and A2/AD capabilities, both of which are designed to prevent timely NATO military responses in defence of the sovereignty of its frontline states and restrict NATO's freedom of action in all operating domains. Future force planning scenarios should also include realistic assumptions regarding the increasingly contested nature of operational environments across the spectrum of military operations.

The next two chapters in this report will further assess implications of the re-emergence of great power competition and the financial environment facing RAF planners. A final chapter will build on these insights and outline a candidate force planning construct for sizing and shaping the RAF's future capabilities and force structure capacity.

CHAPTER 2

Key Resource and Force Structure Trends

Since the end of the Cold War, the United Kingdom and many of its NATO allies reaped significant peace dividends by cutting their defence expenditures and downsizing their militaries. Although these trends reversed somewhat in the decade after the September 11, 2001 attacks on the United States, most new military capabilities procured by the United Kingdom were better suited for counter-terrorism and counter-insurgency operations than for deterring aggression by a great power. With the return of great power competition, the United Kingdom should once again focus on capabilities and capacities required for high-end, state-on-state warfare. To date, the UK has made a modest commitment towards increasing resources to modernise its military. It is uncertain, however, if each of its military Services will benefit equally from these investments. For instance, while the United Kingdom has committed to increasing its spending on military equipment by 1 percent above inflation through FY 2021, the RAF's equipment budget will actually shrink by one third in real terms from FY 2018 to FY 2026.³⁵

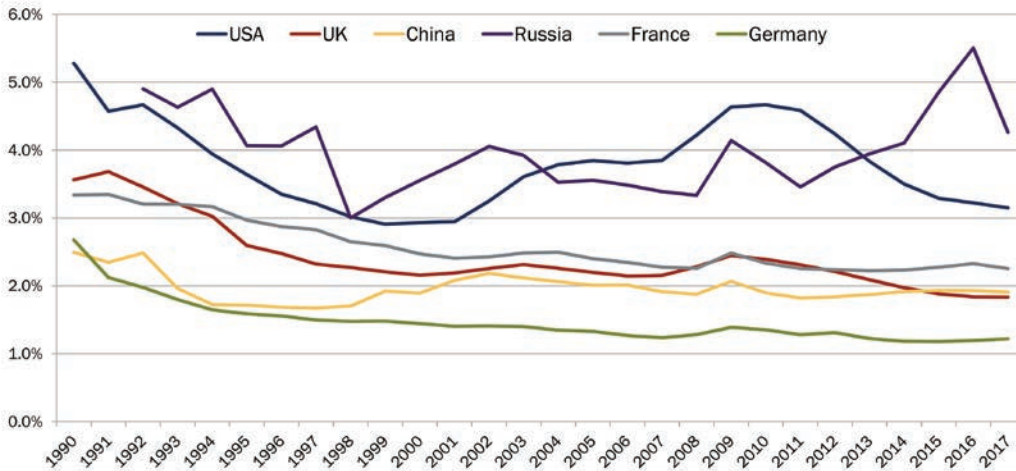
This chapter provides information on key budgetary and force structure trends for the United Kingdom, its allies, and its competitors since 1990. It also highlights major factors that affect the RAF's planning, such as the operational demands placed on the RAF, increases in the cost of sustaining its forces, and the potential for UK defence exports to help subsidise its future force development efforts.

35 MoD, *Ministry of Defence Annual Report and Accounts 2017–18* (United Kingdom: MoD, 2018); and MoD, *The Defence Equipment Plan 2018* (United Kingdom: MoD, 2018).

Comparing Trends in Defence Expenditures, 1990 to 2017

The United Kingdom, United States, France, Germany, Russia, and China decreased defence spending as a share of their GDPs for most of the first decade after the Cold War. Although using GDP percentage as a measure for defence spending is not indicative of absolute defence spending levels, it does suggest that other priorities were of increasing importance for these states in the immediate aftermath of the Cold War.³⁶ As a point of comparison, the United Kingdom averaged close to 6 percent of its GDP on defence throughout the Cold War. This has since decreased to an average that is slightly over 2 percent of GDP (see Figure 4).³⁷

FIGURE 4: MILITARY EXPENDITURES AS PERCENT OF GROSS DOMESTIC PRODUCT



Data from SIPRI, "Database on Military Expenditure." The Chinese estimate reflects estimated total military expenditure, which includes some items not in the official defence budget. For more on SIPRI's sources and methods, see "SIPRI Military Expenditure Database Sources and Methods," available at <https://www.sipri.org/databases/milex/sources-and-methods>.

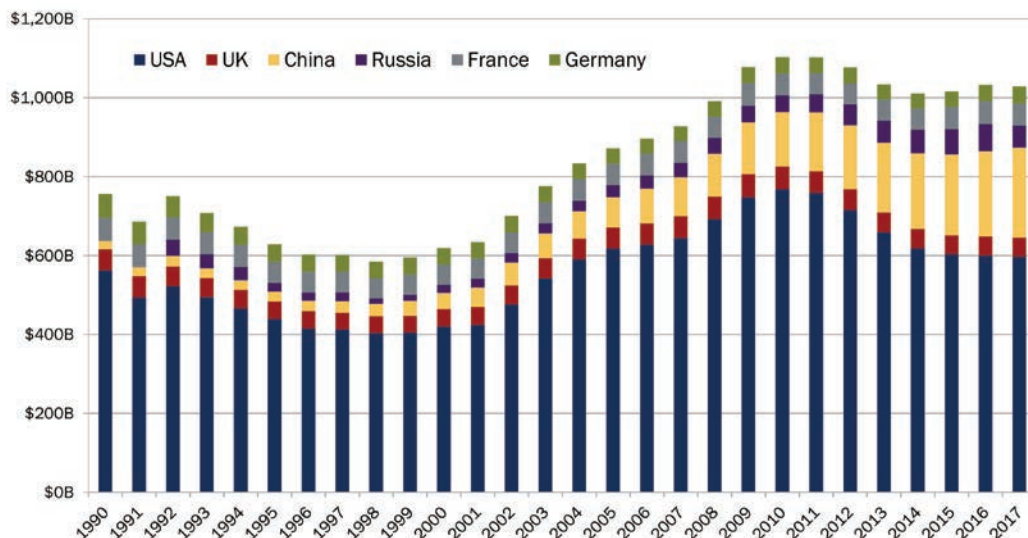
Defence spending trends changed in the late 1990s and early 2000s (see Figure 5). Defence spending increases by the United Kingdom, United States, France, and Germany in the 2000s were driven more by each country's involvement in counter-terror and counter-insurgency operations than concerns about a rising China or Russia. In contrast, Russian and Chinese defence spending increases starting in the 1990s were motivated primarily by a desire for regional supremacy and the perceived need to counter U.S. military advantages. Russia increased its expenditures due to priorities established by Vladimir Putin, a growth in revenues from its energy exports, an awareness of the effectiveness of U.S. operations against Iraq in 1991, and concerns over the Russian military's shortfalls during operations in Chechnya and

³⁶ Chinese spending increased in absolute terms throughout this period, but due to China's rapid economic growth, defence spending decreased as a percentage of GDP until the late 1990s.

³⁷ Stockholm International Peace Research Institute (SIPRI), "Database on Military Expenditure," available at: <https://www.sipri.org/databases/milex>.

later in Georgia.³⁸ The Chinese government also increased its defence spending in reaction to the dominance the U.S. military displayed during Operation Desert Storm. Other factors included the Chinese leadership's concern over a Taiwanese drive for independence and the Chinese Communist Party's implicit guarantee to the PLA that real funding cuts started in the 1980s would be reversed once China had developed sufficiently.³⁹

FIGURE 5: MILITARY EXPENDITURES, CY 1990–2017



Data from SIPRI, "Database on Military Expenditure." Amounts in constant 2016 U.S. dollars.

Although absolute defence spending may be a better indicator of a country's military potential than percent of GDP, comparisons of absolute defence spending should be considered in the context of their individual national aspirations. The United States spends more on its military than the next seven countries combined, which is consistent with its global security commitments and responsibilities. Competitors like China and Russia whose geopolitical aspirations are more regionally focused, at least in the short-term, are able to direct their defence

38 For Putin and much of Russia, "The collapse of the Soviet Union was a major geopolitical disaster of the century." This feeling was compounded by NATO's Operation Allied Force to halt the fighting in Kosovo, which left "Russians feeling humiliated for having a country that no longer carr[ie]d any weight in international politics." Putin has sought opportunities to rebuild Russia's greatness in their eyes and those of the world. Oil-fuelled increases in military expenditures is one reflection of that drive. See Vladimir Putin, "Annual Address to the Federal Assembly of the Russian Federation," *President of Russia*, April 25, 2005; Masha Gessen, "Dispatches from the War Zone," *Slate*, May 11, 1999; Masha Gessen, "Crimea is Putin's Revenge," *Slate*, March 21, 2014; and Masha Gessen, *The Future is History: How Totalitarianism Reclaimed Russia* (New York: Riverhead Books, 2017). For more on Russian military modernisation, see Bettina Renz and Rod Thornton, "Russian Military Modernization: Cause, Course, and Consequences," *Problems of Post-Communism* 59, no. 1, 2012; Dale R. Herspring, "Vladimir Putin and Military Reform in Russia," *European Security* 14, no. 1, 2005; and Defense Intelligence Agency (DIA), *Russia Military Power: Building a Military to Support Great Power Aspirations* (Washington, DC: DIA, 2017).

39 Tai Ming Cheung, *Fortifying China: The Struggle to Build a Modern Defense Economy* (Ithaca and London: Cornell University Press, 2009).

investment towards achieving their more discrete and localised priorities.⁴⁰ This prioritisation could provide Russia and China with opportunities to gain significant localised and temporal advantages relative to their competitors.⁴¹

The United Kingdom has long considered itself as one of the world's leading military powers, and its annual defence spending still ranks among the largest in Europe. Like the United States, the United Kingdom has global interests, such as maintaining the security of the Falkland Islands, meeting its NATO commitments, and sustaining security relationships with Malaysia, Singapore, Australia, and New Zealand established by the Five Power Defence Arrangements.⁴² Maintaining the UK's influence and power with significant budget constraints requires the MoD to be highly efficient as it develops, procures, and sustains new capabilities. One approach to improving efficiency is to shift away from procuring single purpose, niche weapon systems in favour of multi-mission capabilities that are useful across a range of operational scenarios. This is particularly important given the United Kingdom has significantly reduced its defence spending in real terms since the end of the Cold War, whereas Russia has increased spending on its military by 63 percent since 1992, and China's defence spending is 984 percent greater than it was in 1990.⁴³

Comparing Trends in Force Structure, 1990 to 2018

Most of the Cold War's principal actors also cut their military personnel end strength after 1990 (see Figure 6). These cuts were driven by decreases in defence spending as discussed above, as well as increases in the cost per person to support a professional, educated military force.⁴⁴ Post-Cold War end strength drawdowns for Western powers were driven primarily by the desired peace dividend. In contrast, Chinese and Russian end strength cuts were driven by their transition from a conscript force to a professional force as well as other financial

40 While China has global interests, such as trade flows and Chinese citizens abroad, its military capabilities are still predominantly regionally focused. The People's Liberation Army, however, is expanding its ability to project power globally to protect China's expanding interests. For more on the expansion of Chinese military capabilities, see Christopher P. Carlson and Jack Bianchi, "Warfare Drivers: Mission Needs and the Impact on Ship Design," in Andrew S. Erickson, ed., *Chinese Naval Shipbuilding: An Ambitious and Uncertain Course* (Annapolis, MD: Naval Institute Press, 2016).

41 Eric Heginbotham et al., *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996-2017* (Santa Monica, CA: RAND Corporation, 2015); and David A. Shlapak and Michael Johnson, *Reinforcing Deterrence on NATO's Eastern Flank: Wargaming the Defense of the Baltics* (Santa Monica, CA: RAND Corporation, 2016).

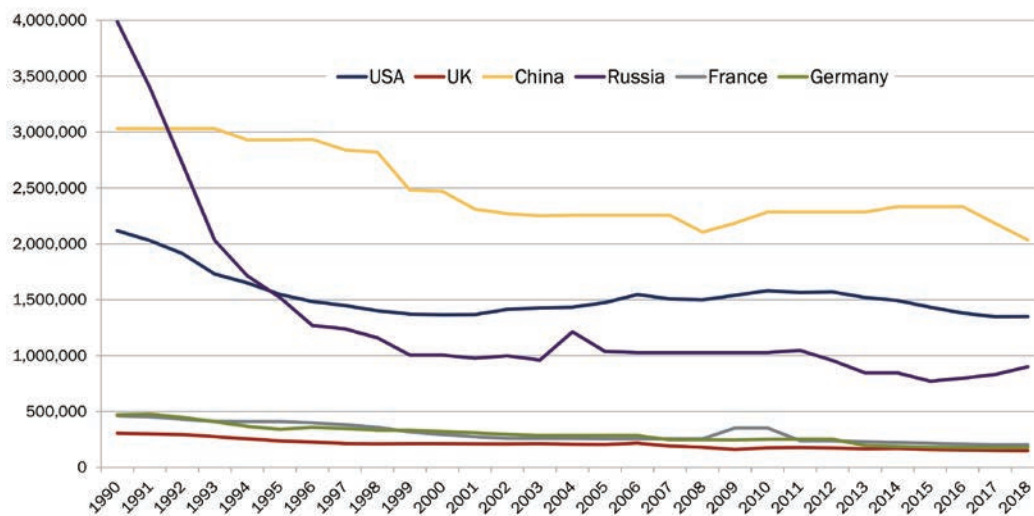
42 The Five Power Defence Arrangements mandates consultation between Malaysia, Singapore, Australia, New Zealand, and the United Kingdom in case of attack or significant threat against Malaysia or Singapore, but it does not require joint action. The signatories could decide to react jointly or individually to any given crisis. See, J. Vitor Tossini, "The Five Power Defence Arrangements," *UK Defence Journal*, February 28, 2017.

43 Defense spending calculations are based on data from SIPRI, "Database on Military Expenditure."

44 For an assessment of aircraft cost growth increases, see Mark V. Arena et al., *Why Has the Cost of Fixed-Wing Aircraft Risen?* (Santa Monica, CA: RAND Corporation, 2008); and Steven M. Kosiak, *Is the U.S. Military Getting Smaller and Older? And How Much Should We Care?* (Washington, DC: Center for a New American Security, March 2017).

pressures.⁴⁵ Most Western powers ended conscription in the middle of the Cold War in favour of maintaining professional all volunteer forces.⁴⁶ Volunteers tend to serve longer terms than conscripts, which improves, on average, their proficiency and readiness to operate increasingly complex and lethal military systems. An all-volunteer force can also increase personnel costs, including the cost to recruit, train, and provide sufficient pay and benefits to retain experienced personnel in the force.

FIGURE 6: TOTAL MILITARY ACTIVE PERSONNEL



Data from IISS, *The Military Balance* (London: Oxford University Press, 1990–2018).

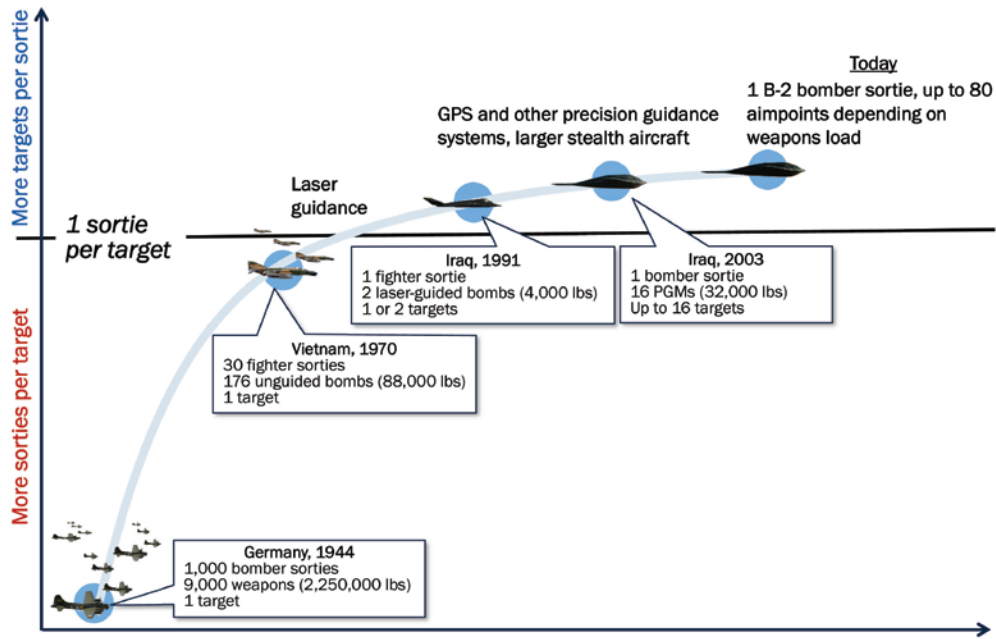
Trends in Aircraft Inventories

Operation Desert Storm against Iraq in 1991 heralded the arrival of the age of precision airstrikes. During World War II, it could take hundreds of Allied bomber sorties and thousands of weapons to ensure large targets such as industrial complexes in Germany and Japan were destroyed. In Desert Storm, one fighter equipped with the means to deliver laser-guided weapons could destroy several targets per sortie. As precision guidance technologies matured, they allowed the world's air forces to achieve the effect of mass by relying instead on smaller numbers of weapons that can hit targets with great accuracy (see Figure 7).

45 Renz and Tornton, "Russian Military Modernization: Cause, Course, and Consequences," p. 44.

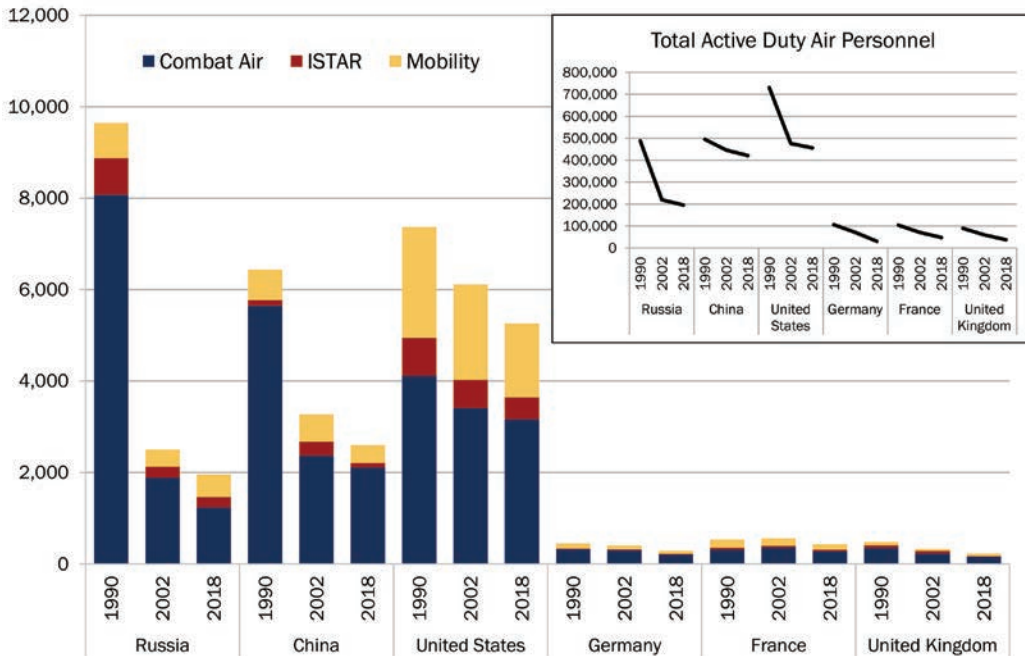
46 For instance, the last conscripts in the UK demobilised in 1963. Richard Davenport-Hines, "National Service: Conscripted in Britain 1945-1963 by Richard Vinen—review," *The Guardian*, August 20, 2014.

FIGURE 7: INCREASED PRECISION DECREASED THE NEED FOR MASS



Data compiled from various sources: United States Strategic Bombing Survey (1945), Government Accountability Office (1997), USCENTAF (2003).

FIGURE 8: TRENDS IN AIRCRAFT INVENTORY AND AIR PERSONNEL (ALL SERVICES)



Data from FlightGlobal, "Flight Fleets Analyzer," online database, updated as of November 4, 2018; and IISS, *The Military Balance* (1990, 2002, 2018). Combat air refers to fighter, bomber, and electronic warfare aircraft. ISTAR aircraft includes airborne early warning, maritime patrol, reconnaissance, and electronic intelligence aircraft. Mobility aircraft includes aerial refuelling and transport aircraft. There is insufficient information on global UAV inventories to include that data.

This leap ahead in capability was also used to justify cuts to the size of the RAF's combat air forces. Although most modern air forces reduced the size of their aircraft inventories over the last forty years, cuts were not always evenly spread across the force. The precision revolution permitted fewer strike aircraft to achieve effects that would have previously required much larger force packages. As such, combat air forces of the world's largest air forces have borne the brunt of cuts. The RAF's overall numbers of intelligence, surveillance, target acquisition, and reconnaissance (ISTAR) and mobility aircraft have fluctuated due to operational demand and projected future requirements but have not changed dramatically since 1990 (see Figure 8).

The "big six" countries shown in Figure 8 are slowly modernising their air forces as Cold War-era aircraft age out. The United States and the United Kingdom are further down the glidepath towards transitioning to 5th generation stealth aircraft.⁴⁷ China and Russia are developing 5th generation aircraft, although it is expected that China will likely deploy them in significant numbers, whereas Russia has no current plans for mass producing the Su-57, its supposed 5th generation aircraft.⁴⁸ ISTAR and mobility platforms are also being replaced, although those modernisation programmes are not as far advanced as 5th generation fighter programmes. The U.S. Air Force continues to debate what should replace its aging E-3A Airborne Warning and Control System (AWACS) and E-8C Joint Surveillance Target Attack Radar System (JSTARS) aircraft. The RAF is planning on replacing its E-3D Sentry AWACS and is in negotiations to procure the E-7 Wedgetail that is now operated by the Royal Australian Air Force.

Trends in Naval Force Structure

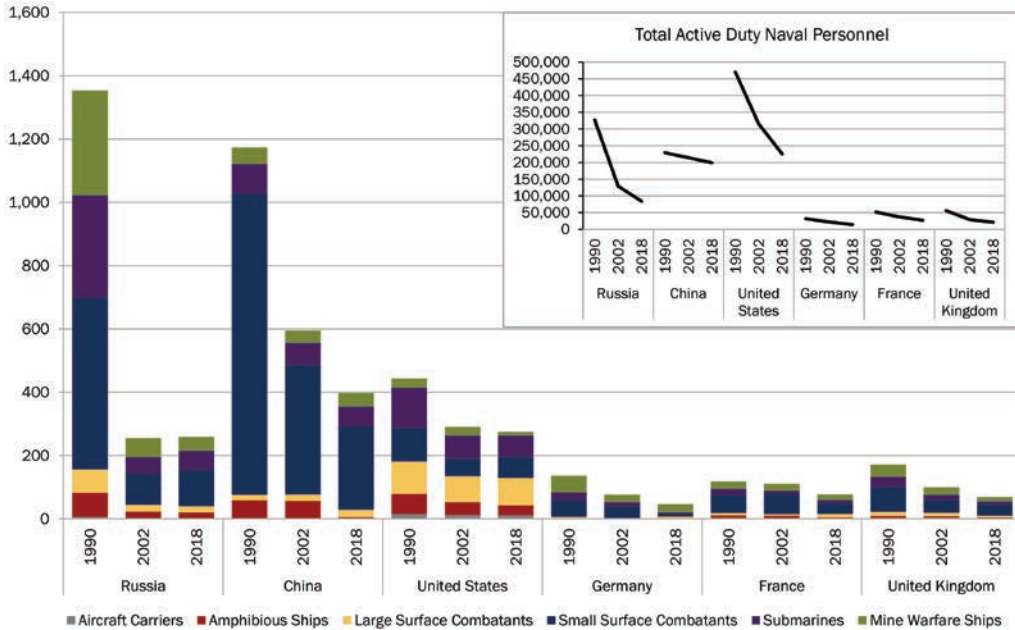
The first twenty-plus years after the Cold War was a period of significant change for many of NATO's navies. During the Cold War, West Germany's navy focused on anti-submarine warfare and sea denial in the Baltic Sea, and the Royal Navy maintained substantial anti-submarine warfare and sea control capabilities focusing much of its attention on Soviet activities in the North Atlantic. With the dissolution of the Soviet Union, NATO navies no longer faced a great power competitor to justify their force structure and modernisation plans. Naval force structure shrunk in size as modernisation plans were cancelled, truncated, or stretched out (see Figure 9).⁴⁹

47 "Fifth-generation fighters truly fuse multiple on-board offensive and defense sensor systems with off-board information to present a smart, networked digital data-presentation to the pilot. Fifth-gen also combines advanced low observable technologies previously incorporated into limited platforms (SR-71 Blackbird, F-117 Nighthawk, B-2 Spirit) with advanced handling characteristics on par with, or in excess of fourth-gen aircraft. In addition, fifth-gen may include increased engine thrust that enables sustained supersonic flight without the need for inefficient afterburner, i.e., supercruise." Jeffrey Hood, "Defining the 5th Generation Fighter Jet," *Joint Base Langley-Eustis Commentaries*, March 14, 2017.

48 Franz-Stefan Gady, "Russia Will Not Mass-Produce 5th Generation Stealth Fighter Jet," *The Diplomat*, July 12, 2018.

49 For more on European Naval power in the post-Cold War Era, see Jeremy Stöhs, *The Decline of European Naval Forces: Challenges to Sea Power in an Age of Fiscal Austerity and Political Uncertainty* (Annapolis, MD: Naval Institute Press, 2018).

FIGURE 9: TRENDS IN BATTLE FLEETS AND PERSONNEL AFTER THE COLD WAR



Data from IISS, *The Military Balance* (1990–2018).

Some NATO states, including the United Kingdom and the United States, directed resources towards maintaining and modernising their naval forces to project conventional power and conduct expeditionary operations against regional aggressors such as Iraq at the expense of anti-submarine warfare, sea control, and other Cold War-era missions.⁵⁰ Germany also invested in blue water naval capabilities, but since its overall fleet size shrank so dramatically, the percentage of its fleet capable of anti-submarine and mine-warfare actually increased. France maintained a similar balance of capabilities during and after the Cold War, but its fleet size decreased as modernisation programmes were stretched out and new ships entered the fleet at a slower rate than older ships were retired.

During the same period, the size of Russia and China’s fleets fell dramatically, although for different reasons. In Russia’s case, major budget cuts resulting from its economic crisis in the 1990s forced it to cancel or delay many of its naval modernisation programmes. The Russian Navy preserved its most capable ships and retired others that were not cost-effective to maintain. Starting in the early 2000s, Russia focused its naval investments on modernising its undersea forces and developing multi-mission small surface combatants capable of carrying long-range missile systems. When those programmes finish, it is likely that Russia will

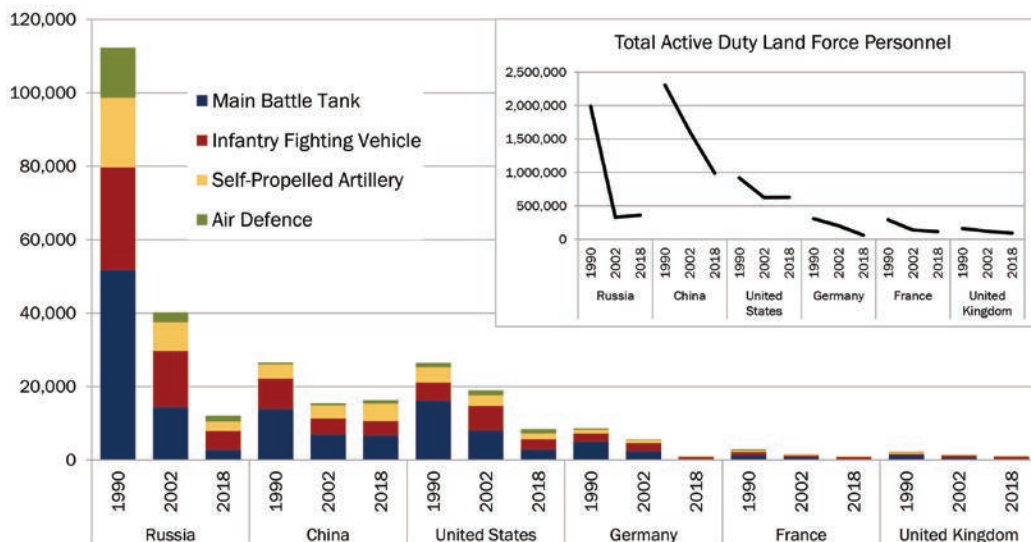
50 For example, the 1998 *Strategic Defence Review* outlined a transition from the Cold War requirement of significant homeland and continental defense requirements towards needing to “prevent or shape crises further away and, if necessary, to deploy military forces rapidly before they get out of hand.” See MoD, *Strategic Defence Review* (United Kingdom: MoD, 1998), p. 29.

modernise its larger ships as well.⁵¹ Although China's navy adopted similar modernisation priorities, its downsizing in the early 1990s was driven more by the need to free resources to build a more modern and professional navy than the need to decrease defence spending.⁵²

Trends in Land Forces

In many ways, Cold War-era land combat doctrine was a question of time and space: does an attacker's ability to quickly mass forces and advance towards an objective outmatch a defender's ability to mass enough forces to delay and defeat that advance? Large, heavy land forces were critical to tilting the balance of power, time, and space in one's favour. Absent a competitor like the Soviet Union, reductions in land forces at the end of the Cold War was a logical means for major military powers to achieve defence savings. As illustrated by Figure 10, the United Kingdom, United States, France, Germany, Russia, and China all decreased their Army end strength and shifted the balance of their land forces from more expensive armoured units to less expensive light units.

FIGURE 10: TRENDS IN LAND FORCE HEAVY EQUIPMENT AND PERSONNEL



The data is sourced from IISS. Not all data elements are consistently tracked in IISS. For instance, the 1990 section on China does not include quantities for infantry fighting vehicles, self-propelled artillery, surface to surface missiles, or air defense systems. The chart is meant to be illustrative. It is not a complete accounting of forces and equipment. For the source documents, see IISS, *The Military Balance* (1990–2018).

⁵¹ For more on the post-Cold War Russian navy see, Office of Naval Intelligence (ONI), *The Russian Navy: A Historic Transition* (Washington, DC: ONI, 2015). Also, for an assessment of some of the challenges facing Russian naval construction, see Paul Schwartz, *Admiral Gorshkov Frigate Reveals Serious Shortcomings in Russia's Naval Modernization Program* (Washington, DC: Center for Strategic and International Studies, 2016).

⁵² Ronald O'Rourke, *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress* (Washington, DC: Congressional Research Service, August 1, 2018).

France, Germany, the United Kingdom, and the United States reduced their main battle tank inventories by an average of almost 50 percent by 2002. Their active duty land force end strength, however, only fell by an average of 35 percent, which suggests that their heavy forces sustained the most significant cuts and some heavy unit personnel transitioned to lighter units. This makes sense from an operational perspective, since lighter units are easier to deploy over long ranges from homeland garrisons and are better suited for humanitarian assistance and peacekeeping missions. Moreover, there are generally fewer political sensitivities to cutting platforms and modernisation spending than there are to reducing end-strength.

This shift towards lighter units continued through 2018, with inventories of main battle tanks falling by an average of 73 percent since 2002. While active duty end strength continued to decline during the same period, the trend was not uniform. The German Army reduced its end strength by an additional 91 percent, while the British Army had a more gradual decline. In contrast, the rate of decline for the French Army decreased significantly, and U.S. Army and Marine Corps end strength levelled out. These trends were motivated by fiscal pressures and operational demand for land forces, such as the long-running U.S. counterinsurgency campaigns in Iraq and Afghanistan. These trends may change with the return of great power competition. The armies of the United Kingdom and United States are both emphasising the need to prepare for conflict with a peer competitor, including the necessity of revitalising some land warfare units that are heavier and more lethal than light forces.⁵³

Russian and Chinese land forces also contracted in size after the Cold War, but for reasons that were different than those that motivated NATO's cuts. Both Russia and China decreased their reliance on conscript forces and are transitioning towards more professional, smaller armies. Similarly, both are reducing stores of outmoded equipment and replacing them with modern systems. Given the increased cost and lethality of state-of-the-art weaponry, however, old equipment is not being replaced on a one-for-one basis.⁵⁴ Additionally, neither Russia nor China invested significant funds to develop new equipment such as mine-resistant ambush protected vehicles that are useful only for counter-insurgency operations. Instead, they have consistently focused on modernising for great power competition.⁵⁵

53 MoD, *SDSR 2015 Defence Fact Sheets* (United Kingdom: MoD, 2016).

54 China and Russia have pursued ambitious military modernisation programmes to improve the qualitative aspects of their forces. See Connolly and Boulègue, *Russia's New State Armament Programme*; and Michael S. Chase et al., *China's Incomplete Military Transformation: Assessing the Weaknesses of the People's Liberation Army (PLA)* (Santa Monica, CA: RAND Corporation, 2015), pp. 13–24, 78. The authors assess that while some progress is being made in the development of new-generation equipment, modern systems will not replace legacy systems at a one for one ratio. The PLA's overall force structure will continue to shrink, but modern systems will still be operated alongside a mix of legacy equipment.

55 The United States invested substantial modernisation funding in counter-insurgency driven equipment. Much of this was discarded when the majority of U.S. forces withdrew from Iraq and Afghanistan. Ginny Fahs, "U.S. Army to Scrap \$7 Billion in Equipment in Afghanistan," *National Public Radio*, June 20, 2013.

Summarising Trends in Force Structure

Three trends emerge from this force structure assessment. First, militaries are becoming more lethal, smaller, and increasingly professional. Second, the security environments of the 1990s and 2000s that allowed militaries to take risk with respect to their size and resilience are artefacts of the past. Smaller militaries, even militaries that are equipped with more lethal weapon systems, may be substantially less resilient than their Cold War predecessors in today's contested operational environments. As defence planners assess future modernisation requirements, improving resilience as well as lethality should be a priority. Third, the post-Cold War trend of seeking major cuts to military spending and force structure is changing. The Russian and Chinese militaries have consistently invested their modernisation funding in preparation for state-on-state conflict, whereas Western powers have prioritised their resources for operations in the Middle East and counter-terrorism missions more broadly. In other words, Russian and Chinese militaries have a head start over Western militaries in preparing for great power competition. Consequently, a number of capability advantages Western militaries are accustomed to having over competitors have been eroded.

The remainder of this chapter will take a closer look at the budgetary and force structure trends that shaped a Royal Air Force that is now stretched to the brink by requirements to support current operations and simultaneously fund modernisation programmes needed for it to remain a top tier air force.

A Closer Look at the United Kingdom

Trends in MOD Expenditures, Force Structure, and Personnel

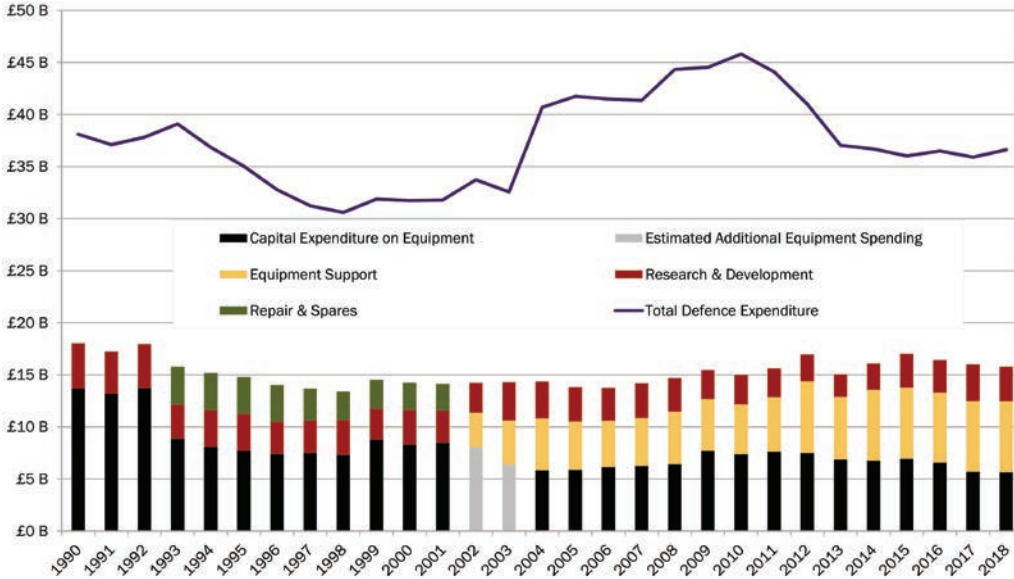
Adjusted for inflation, the United Kingdom's defence budget in 2018 was almost £1.5 billion less than it was in 1990.⁵⁶ The UK's post-Cold War total defence spending reached its nadir in 1998 and peaked in 2010 (see Figure 11).

The MoD's longest period of funding growth ran from 2003 to 2010. Much of this growth was the result of costs associated with the UK military's deployments to Iraq and Afghanistan. As shown by comparing the purple line with the bar chart in Figure 11, the United Kingdom's increased levels of defence spending from 2003 to 2010 was not matched with substantial increases in expenditures on equipment. Moreover, most of the limited increases in

56 The budgetary structure of the MoD often does not show separately the costs of the three individual Armed Services (Royal Navy, Army, and Royal Air Force). This position—that large parts of the Armed Services operate as fully integrated joint organisations in which elements from the Navy, Army, and Air Force work closely together and share land, buildings, and facilities, and sometimes equipment—is a position consistently articulated in all major government reports and requests for information of this kind.

equipment spending was consumed by procuring and sustaining equipment for current needs, not modernising for future challenges.⁵⁷

FIGURE 11: UK TOTAL DEFENCE SPENDING AND EQUIPMENT SPENDING BREAKOUT

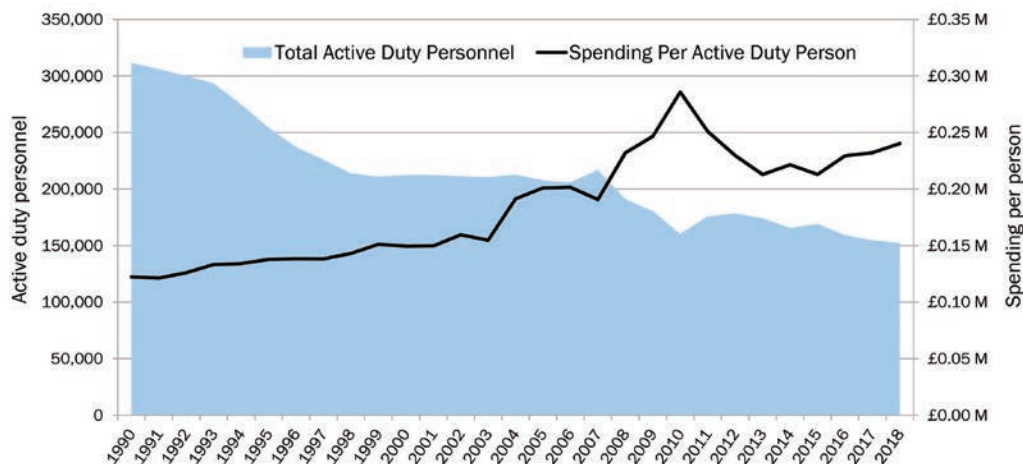


Data sourced from the MoD’s Ministry of Defence Annual Report and Accounts for the years 2003–2018 and its UK Defence Statistics Compendium for the years 1992–2013. Amounts adjusted to FY 2018 £ using GDP deflators from the Office for National Statistics, “GDP Deflators at Market Prices, and Money GDP June 2018 (Quarterly National Accounts),” HM Treasury, June 29, 2018 available at <https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-june-2018-quarterly-national-accounts>. UK government accounts did not provide a complete breakdown of equipment spending for 2001–2003. CSBA identified R&D funding for those years, but could not determine the funding allocated towards the other categories of the equipment expenditures. Estimated additional equipment spending is represented in grey to evenly distribute funding changes between the known years of 2001 and 2004.

Increased personnel costs were another factor that drove the budget and crowded out investments in modernisation programmes. The MoD’s defence budget share per active duty person almost doubled from 1990 to 2017 (see Figure 12). Decreasing resources, forces, and personnel are not inherently problematic as long as the demands placed on a military also decline. The British Army, Royal Air Force, and Royal Navy are all substantially smaller than at the end of the Cold War. The RAF’s forces, however, shrank at the fastest rate of the three services. Its force structure was cut roughly four times faster than the Navy and almost twelve times faster than the Army. RAF active end strength also shrank by the greatest proportion, although in absolute terms the Army lost the most people. The Royal Air Force reduced its personnel by 63 percent, the Navy by 49 percent, and the Army by 44 percent (see Figure 13).

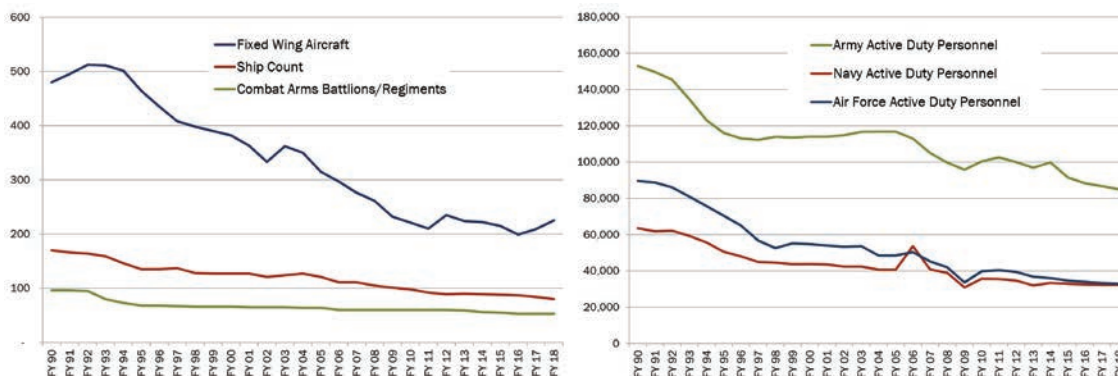
57 For example, the MoD procured new armored vehicles and up-armored existing ones to counter the threats posed by improvised explosive devices (IED) in Afghanistan and Iraq. MoD, “Afghanistan: The Changing Nature of Equipment,” October 28, 2014, available at <http://www.defense-aerospace.com/article-view/release/158371/uk-mod-reflects-on-changing-equipment-in-afghanistan.html>. Additionally, modernisation funding spent on IED-resistant vehicles delayed the recapitalization of vehicles required for conventional state-on-state conflict: “Over half of the combat vehicles in the Army’s inventory are more than 40 years old and ‘many vehicles and key weapon systems are approaching a cliff edge of block obsolescence.’” Louisa Brooke-Holland, *Modernising the Army’s Armoured Fighting Vehicles*, Briefing Paper Number o8186 (United Kingdom: House of Commons Library, 2018).

FIGURE 12: MOD TOTAL SPENDING PER ACTIVE DUTY PERSON



For total end strength data, see IISS, *The Military Balance* (1990–2018). For total spending data, see the MoD, *Annual Reports and Accounts* (United Kingdom: MoD, 2003–2018); and MoD, *UK Defence Statistics Compendium* (United Kingdom: The National Archives, 1992–2013). Amounts in FY 2018 £.

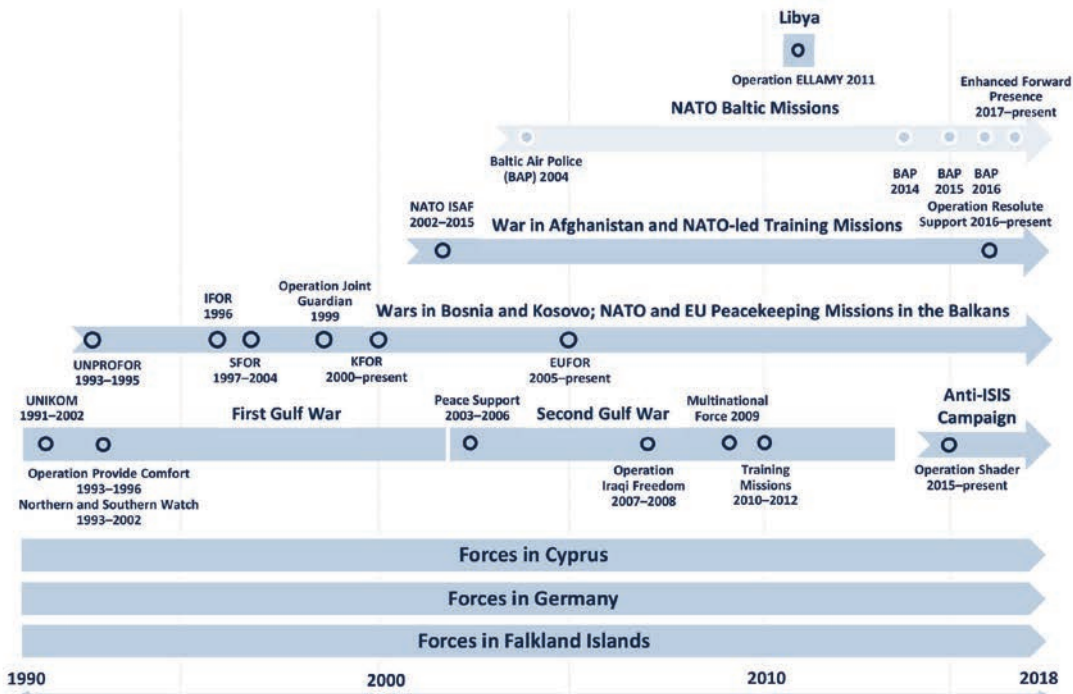
FIGURE 13: MOD FORCE STRUCTURE AND PERSONNEL TRENDS BY SERVICE



The United Kingdom did not publish FY 2015 force structure figures on ships and combat arms units. CSBA used the midpoint between the FY 2014 and FY 2016 numbers to estimate the FY 2015 ship count and combat arms battalion/regiment count. For aircraft inventories, see FlightGlobal, "Flight Fleets Analyzer." For ship and combat arm unit numbers, see MoD, *UK Armed Forces Equipment and Formations* (London: MoD, 2016–2018); MoD, *Military Formations, Vessels and Aircraft* (London: MoD, 2013–2014); and MoD, *UK Defence Statistics Compendium* (1992–2013).

Despite a significantly smaller force, demands placed on the UK military have not decreased proportionately. Since the end of the Cold War, the United Kingdom has deployed forces to more than 16 major operations, many of which occurred simultaneously (see Figure 14). Some RAF aircraft have deployed to every operation, including its Tornado multi-role combat aircraft. Others, such as the Nimrod and the Typhoon, only deployed to a few operations over the same time period, although Typhoon has conducted Homeland Defence since 2006 and only had a declared air-to-ground capability since 2008. While the UK military has far more capable personnel and platforms than it had at the end of the Cold War, its people and aircraft can only be in one place at a time. Britain's military is increasingly stretched to support the operational demands of a nation that remain global in nature.

FIGURE 14: MAJOR OVERSEAS DEPLOYMENT TIMELINES AND RAF AIRCRAFT DEPLOYED



	Cyprus	Falklands	Germany	Gulf War I	Gulf War II	Anti-ISIS	Balkans	Afghanistan	Baltics	Libya	Total
Tornado	X	X	X	X	X	X	X	X	X	X	10
C-130 Hercules		X		X	X	X	X	X		X	7
Harrier			X	X	X		X	X			5
C-17/VC-10		X		X	X					X	4
C-17										X	1
E-3D Sentry					X	X	X			X	4
K-1 Tristar				X	X		X			X	4
Typhoon		X				X			X	X	4
Phantom	X	X									2
MQ-9A Reaper						X		X			2
Nimrod				X	X					X	4
A330 Voyager						X					1
Defender AL1					X						1
Desert Hawk								X			1
Hermes								X			1
Jaguar				X							1
KC-10		X									1
Predator B								X			1
RC-135						X					1
Sea Harrier							X				1
Sentinel R1						X				X	2
Shadow R1								X			1

Data from IISS, *The Military Balance* (1990–2018).

Trends in the RAF's Resources and Force Structure

The precision strike revolution allowed the RAF to increase the lethality of its combat aircraft and simultaneously decrease funding for its combat air forces in the 1990s. The shift towards precision-enabled forces had an opposite effect on the RAF's investments in ISTAR capabilities needed to find, fix, and track potential targets. These trends are reflected in changes to the Service's investments and aircraft inventories (see Figures 15 and 16).

FIGURE 15: RAF FUNDING BY CAPABILITY AREA

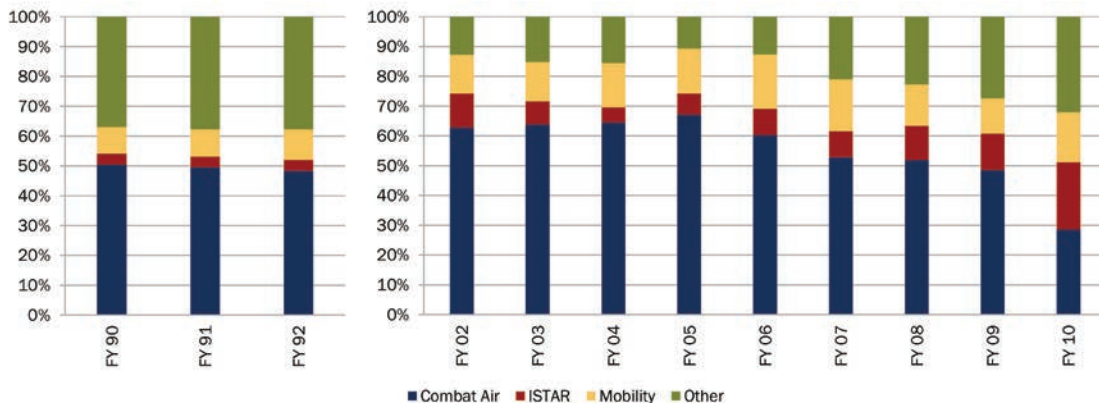
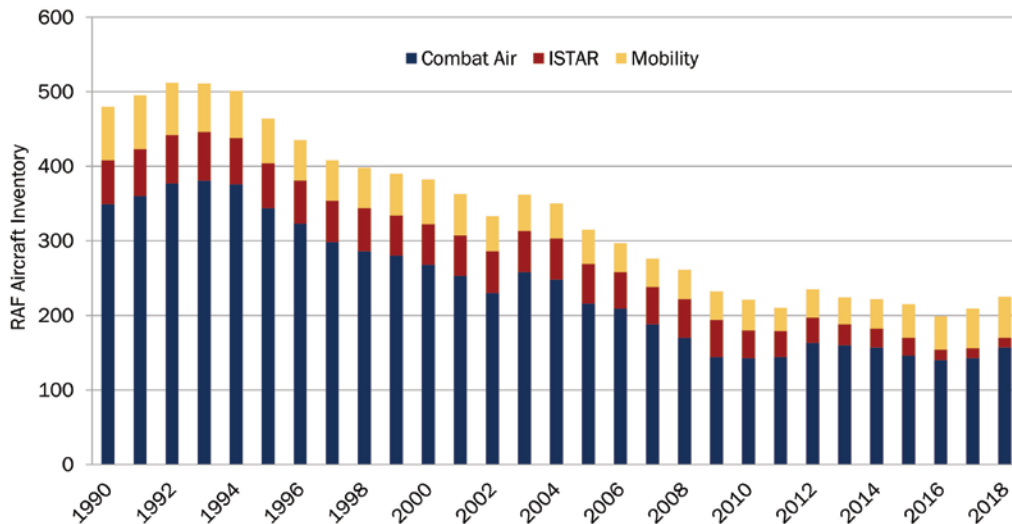


FIGURE 16: RAF AIRCRAFT INVENTORY 1990–2018



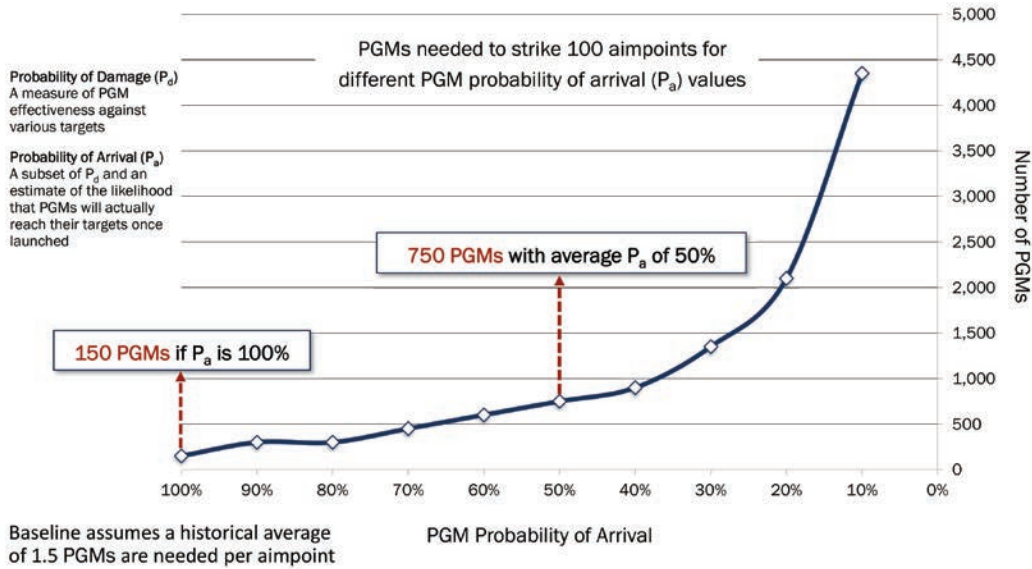
Data for Figure 15 from MoD, *UK Defence Statistics Compendium* (1992–2013). The *Defence Statistics Compendium* did not consistently break down funding by capability area. Figure 15 reflects all publicly available data that, while incomplete, still allows the reader to visualise the increasing resources allocated towards ISTAR capabilities at the expense of Combat Air. Aircraft inventories in figure 16 are derived from FlightGlobal, “Flight Fleets Analyzer.”

As a share of the RAF's publicly reported funding, spending on combat air and ISTAR was fairly static in the first few years after the Cold War. By 2010, combat air funding shrank to roughly 29 percent of the RAF budget and ISTAR funding increased to almost 24 percent

of the budget.⁵⁸ Over the same period the RAF’s combat aircraft inventory decreased by 59 percent, whereas ISTAR aircraft decreased by 37 percent.

Cannibalising combat air forces to sustain or advance other enabling capabilities may be a viable tactic as long as an air force can operate with low risk of significant combat losses. Advanced precision air and missile defences fielded by Russia, China, and others now threaten the ability of attacking aircraft and the weapons they launch to penetrate enemy airspace and strike targets.⁵⁹ As Figure 17 illustrates, increases in the effectiveness of air and missile defence networks reduce the probability that a PGM launched by an attacker will arrive at its intended target (PGM probability of arrival, or P_a).⁶⁰ As PGM P_a values decrease, the number of PGMs and aircraft sorties needed to ensure a target set is successfully attacked increases exponentially.

FIGURE 17: ILLUSTRATIVE IMPACT OF DEFENCES ON THE NUMBER OF PGMs NEEDED TO STRIKE 100 AIMPOINTS



58 From 1990 to 1992 and again from 2002 to 2010, the annual *Defence Statistics Compendium* identified funding towards type of capability. In the later period, the reports also attempted to allocate an appropriate share of support to each identified capability. Since this was not done in the former period, it is impossible to compare trends in real spending. Looking at how the percentage of identified funding towards a capability area changes over time, however, is an indicator of how the RAF prioritised each category of capabilities.

59 Advances in missile defences, decoys, camouflage, electronic warfare, etc. decrease the likelihood that an incoming weapon will hit its desired target. For more on ways to defending against precision strike, see Carl Rehberg and Mark Gunzinger, *Air and Missile Defense at a Crossroads: New Concepts and Technologies to Defend America’s Overseas Bases* (Washington, DC: Center for Strategic and Budgetary Assessments, 2018); and Mark Gunzinger and Bryan Clark, *Winning the Salvo Competition: Rebalancing America’s Air and Missile Defenses* (Washington, DC: Center for Strategic and Budgetary Assessments, 2016).

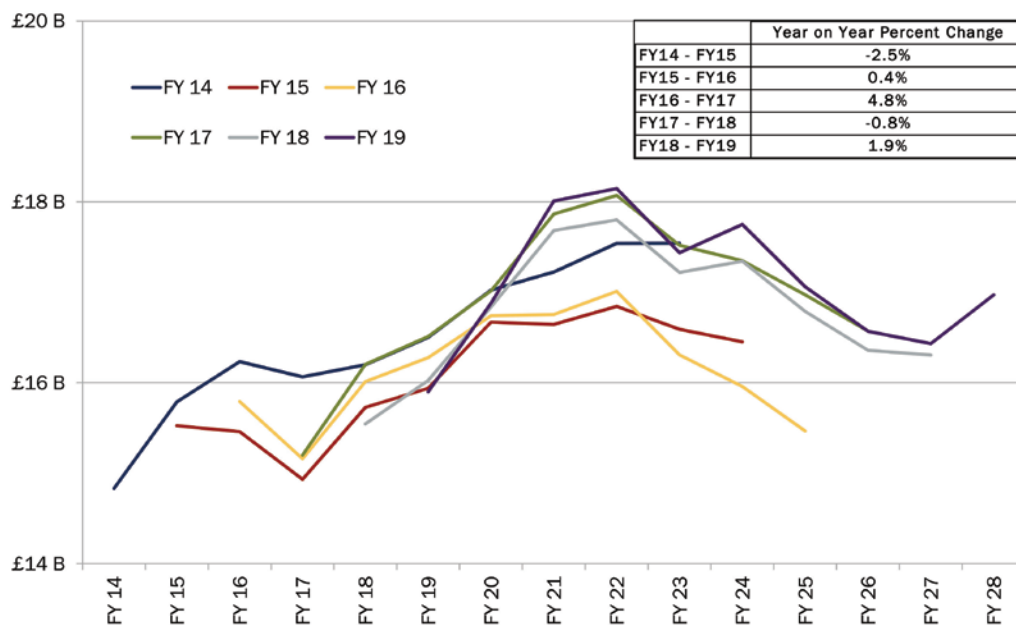
60 For more on trends related to precision strike operations, see Mark Gunzinger and Bryan Clark, *Sustaining America’s Precision Strike Advantage* (Washington, DC: Center for Strategic and Budgetary Assessments, 2015).

While improvements to the lethality of combat aircraft have been part of the rationale for downsizing the RAF's combat air forces since the end of the Cold War, given the maturation of precision-enabled air defences, this assumption may no longer be valid. The RAF should not assume that it will be able to use the same number of sorties and weapons against targets that are defended by advanced IADS as it did during recent air campaigns against opponents that lacked effective defences, or that it will be able to do so without risk of significant attrition. The RAF's ability to generate effective combat mass as well as strike with precision will be essential to overcoming advanced air and missile defences. Furthermore, divesting additional RAF combat aircraft (capacity) to fund other priorities is an increasingly questionable trade-off in an era where competitors are fielding the means to degrade precision strikes.

RAF Acquisition Funding Over Time

Unstable funding projections impede the ability of RAF planners to develop balanced modernisation plans. Figure 18 depicts the MoD's five previous ten-year equipment budget projections in FY 2018 £. As shown in the figure's inset table, projected modernisation funding changed significantly from year to year. Such budget variability renders strategic planning far more difficult.

FIGURE 18: UK MINISTRY OF DEFENCE FY14–FY19 EQUIPMENT PLAN

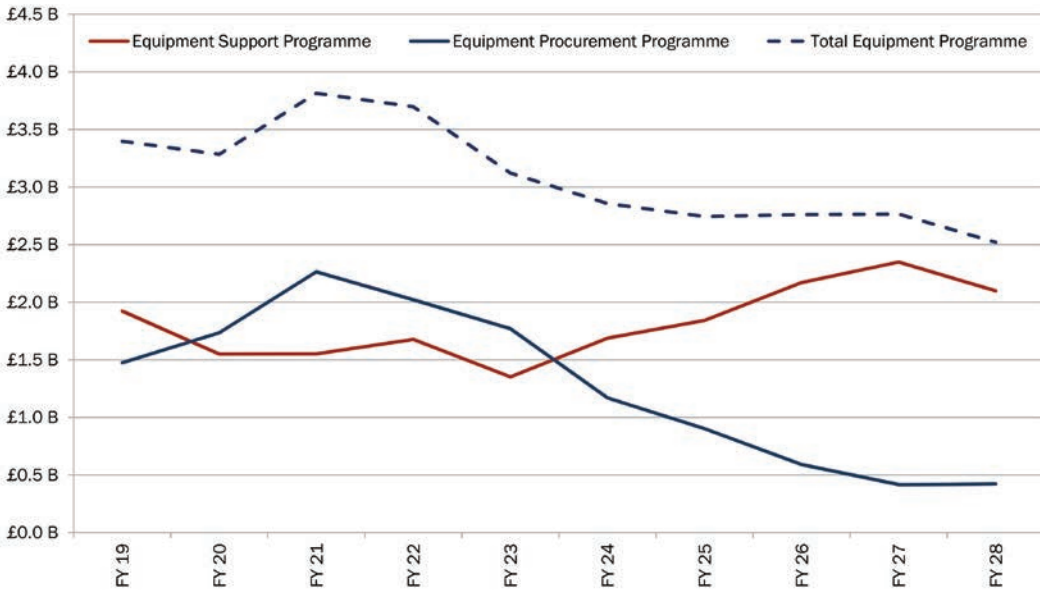


MoD, *The Defence Equipment Plan 2017* (United Kingdom: MoD, 2017), p. 5; MoD, *The Defence Equipment Plan 2018*, pp. 14, 21. Adjusted to FY18 £ using HM Treasury June 2018 GDP deflators.

Growth in the portion of the RAF's equipment budget that may be consumed by increasing costs to support existing capabilities (shown by the red line in Figure 19) would compound problems that are caused by budget instability. In FY 2019, roughly 44 percent of the RAF's

equipment spending is allocated towards developing and purchasing new equipment. By FY 2028, it is projected that just under 19 percent of its equipment spending will be for equipment modernisation.⁶¹ If this projection becomes reality, the RAF’s ability to invest in follow-on systems and modernisation programmes will be crowded out by support costs, making it increasingly difficult for the RAF to keep pace with competitors that are taking advantage of emerging technologies to modernise their forces.

FIGURE 19: COMPARING PLANNED FY19–FY28 RAF EQUIPMENT PROCUREMENT AND SUSTAINMENT SPENDING

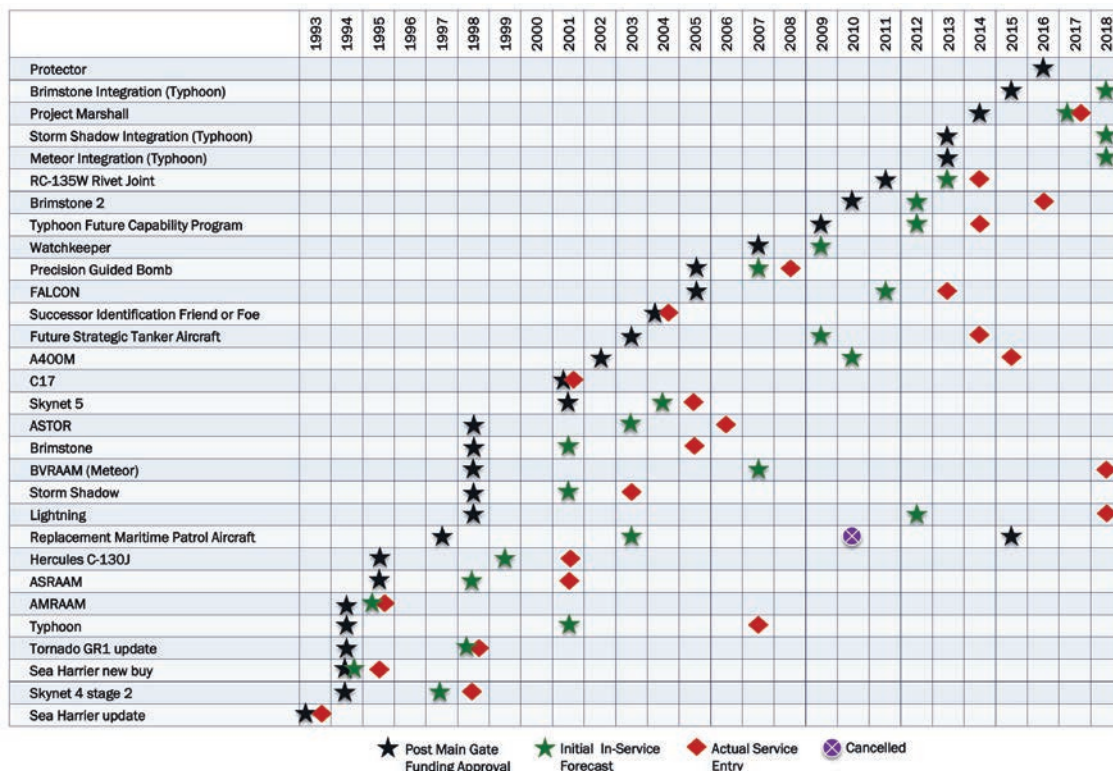


Data adjusted to FY 2018 £ using HM Treasury June 2018 GDP deflators. MoD, *The Defence Equipment Plan 2018*, p. 26.

The RAF’s ability to field a new generation of technologically advanced and highly capable forces would be further threatened by delays to its modernisation programmes. Figure 20 charts the RAF’s major equipment projects from when main investment decision for programmes were made (post Main-Gate, indicated by the blue stars) to the time when new equipment was planned to enter service (green stars) and when equipment actually entered service (red diamonds).

61 The percentage of funding allocated to equipment support and procurement is estimated based off a chart in the 2018 *Equipment Plan*. See MoD, *The Defence Equipment Plan 2018*, p. 26

FIGURE 20: RAF MAJOR EQUIPMENT ACQUISITION PROJECTS AND FORECAST VS. ACTUAL IN-SERVICE DATES



Data sourced from the "Major Equipment Projects" section of MoD, *UK Defence Statistics Compendium* (1992–2013); and MoD, *The Defence Equipment Plan* (United Kingdom: MoD, 2012–2018).

Only five programmes listed in Figure 20 delivered their planned capability on or before their initial forecast in-Service date. Every other programme was late. The Meteor beyond visual range air-to-air missile (BVRAAM), at eleven years behind schedule, was the RAF's most delayed major equipment programme since 1993. The Replacement Maritime Patrol Aircraft was the only programme cancelled during this period, as indicated by the purple X. The MoD's 2015 *Strategic Defence and Security Review*, however, decided to acquire new maritime patrol aircraft by 2020.⁶²

Understanding and Leveraging the Value of Defence Exports

As outlined earlier in this chapter, the military forces of major Western powers, Russia, and China contracted substantially since the end of the Cold War. Although several factors that explain this trend are already noted, it is also due in part to the growing costs of weapons systems, which are substantially driven by the overall quantity procured as well as their

62 MoD, *National Security Strategy and Strategic Defence and Security Review 2015: A Secure and Prosperous United Kingdom* (United Kingdom: MoD, 2016), p. 28.

increasing technological sophistication. Illustrating this relationship, a 2010 RAND study estimated costs associated with extending planned production of F-22 stealth fighters for the U.S. Air Force.⁶³ It considered three scenarios: shutdown and restart aircraft production after a two-year hiatus; maintain limited production of five aircraft per year to sustain industrial capacity until demand increased to the full rate of 20 aircraft per year; or continue production at 20 aircraft per year. The unit costs for each scenario are summarised in Table 1.

TABLE 1: F-22A PRODUCTION OPTIONS AND FLYAWAY UNIT COSTS

Option	Flyaway Unit Cost (Fiscal Year 2008 dollars)
Scenario 1: Shutdown and restart production after 2 years	\$179 million
Scenario 2: Maintain limited production of 5 per year	\$154 million
Scenario 3: Continue production at 20 per year	\$139 million

Data from Younossi et al., *Ending F-22A Production*.

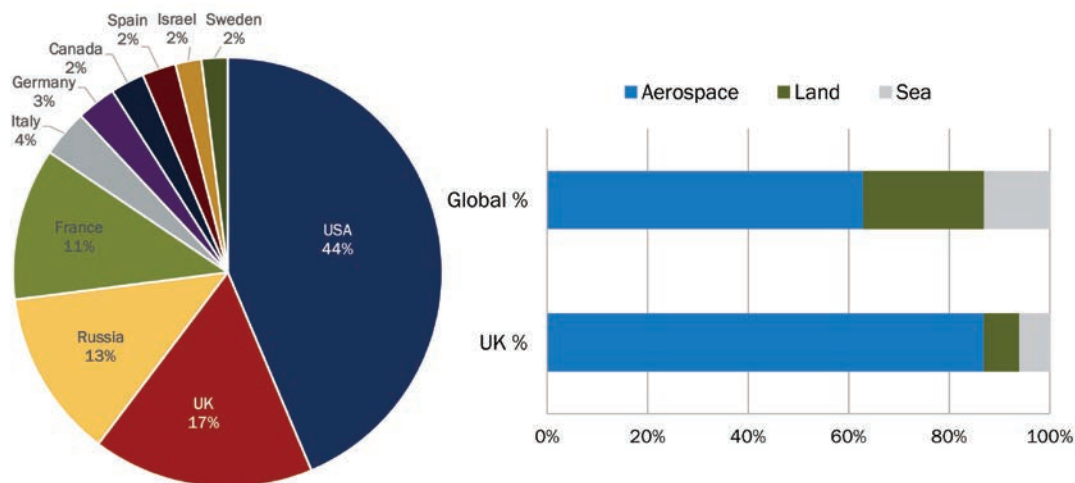
The Air Force would have realised the lowest unit cost if it continued to procure 20 F-22s per year, since higher annual production rates typically decrease unit costs.⁶⁴ Scenario 3 would also take advantage of efficiencies learned during the production of preceding aircraft. In contrast, slowing or cancelling production would result in differing degrees of lost workforce learning, which would increase costs if production were later ramped up or restarted.

Since there may not be sufficient RAF demand to sustain large production runs of new military aircraft, it should consider how export sales could expand aircraft production and help subsidise RAF costs. The United Kingdom has an export-oriented defence industry and is the second largest arms exporter worldwide. From 2008 to 2017, the UK accounted for 17 percent of all sales by the world's top ten defence systems exporters (see Figure 21). Roughly 87 percent of the UK's sales were from the aerospace sector. The UK should consider capitalising on and sustaining, either in a consortium or alone, its existing aerospace expertise and historical reputation to increase the potential return on investment in the defence sector. Increased efforts to expand defence exports, particularly in the aerospace sector, could further subsidise the procurement of capabilities for the RAF and ease the problem of bringing combat mass back to the RAF.

63 Obaid Younossi et al., *Ending F-22A Production: Costs and Industrial Base Implications of Alternative Options* (Santa Monica, CA: RAND Corporation, 2010).

64 While not always true, increases in production rates tend to decrease average unit costs. In the case of the F-35, for example, the price per jet has declined as production increased. See Mike Stone, "Lockheed Agrees to Cut Price for New F-35 Fighter Jets: Pentagon," *Reuters*, September 28, 2018. For a general analysis of the relationship between cost and production rates, see Joseph P. Large, Karl Hoffmayer, and Frank Kontrovich, *Production Rate and Production Cost* (Santa Monica, CA: RAND Corporation, December 1974).

FIGURE 21: 2008–2017 TOP DEFENCE EXPORTERS AND UK DEFENCE EXPORT MARKET



Export data covering the period 2008 to 2017 sourced from Department for International Trade Defence and Security Organisation (DIT DSO), *UK Defence and Security Export Statistics for 2017* (United Kingdom: DIT DSO, 2018).

Valuing New Weapon Systems in the Context of Future Military Operations

The MoD and RAF are assessing how their procurement priorities should change to address challenges posed by the return of great power competition. Hollowed out by decades of cuts and overstretched by operations in multiple regions, UK military planners should seek to maximise the value for money as they consider how to best recapitalise capabilities that were allowed to atrophy following the end of the Cold War. They should also assess potential acquisition investments through the lens of their future operational utility. In other words, they should compare the cost to develop and procure new capabilities to their future operational potential.

Consider the development of the Watchkeeper WK450 unmanned aerial vehicle (UAV). Based on the Israeli Hermes UAV, the Watchkeeper was late to deliver and over cost. Expected to cost £800m and first enter service in 2010, the programme ultimately required £1.2 billion. The new UAVs were plagued by accidents and, after a handful of sorties in Afghanistan, were withdrawn in 2017.⁶⁵ Even without these challenges, the future warfighting potential of Watchkeeper UAVs should be questioned since they were designed to conduct surveillance operations in highly permissive conditions. Additionally, they have limited autonomy and require a degree of ground-based command and control that may be vulnerable to attacks through cyberspace and the electromagnetic spectrum.

Another unmanned system funded by the MoD, the Taranis UAV, required six years of development to first flight in 2013. The Taranis was a technology demonstrator to prepare for the development of a next-generation stealth combat air platform planned for the 2030s that

65 Ben Farmer, "Army Grounds £1bn Drone Fleet after Two Crash," *The Telegraph*, September 13, 2017.

would have long range and advanced autonomous capabilities. Technology developed for Taranis could have informed a combined Anglo-French Future Combat Air System (FCAS) programme. This partnership is now jeopardised by disagreements over future requirements and a French agreement with Germany to develop their own FCAS based on the French Neuron UCAV design.⁶⁶ While Taranis may not mature into a procurement programme, it reflects a realistic identification of the need for the RAF to have a survivable surveillance and strike capability given the contested character of future operating environments. It also highlights that, while sharing the costs of developing modern aircraft with international partners is a tempting idea, it is essential to ensure that partners have a common vision of the desired capability. As the RAF considers future modernisation programmes, the Taranis venture is a mixed example: it identified a critically needed capability, but it also highlights how partnering with other nations can increase the risk that developmental capabilities will not transition to the operational force.

Determining the relative operational value of new weapon systems also applies more broadly to the United Kingdom's Joint Force. Future strategic and operational environments will largely determine the kind of forces and capabilities that will be in high demand in major conflicts. In a NATO Article V conflict with Russia set in the Baltic Sea region, for example, *Queen Elizabeth*-class aircraft carriers could only operate north of the GIUK Gap in the Norwegian fjords at very high risk. Operating carriers far from Kaliningrad and the rest of Russia as NATO carriers did during the Cold War would no longer reduce the probability that Russian forces would locate and accurately track them. With an estimated maximum unrefuelled radius of 450 nautical miles under perfect conditions, the short take-off and vertical landing (STOVL) F-35B carried by the HMS *Queen Elizabeth* would have a range disadvantage compared to land-based F-35As that have an estimated unrefuelled combat radius of 590 nautical miles and could operate from airfields located closer to the Baltic states (see Figure 22).⁶⁷

Although operating the HMS *Queen Elizabeth* closer to the Baltic Sea would increase time in the battlespace for its F-35Bs, it would also increase risk to the carrier strike group even further. Even if supported by aerial refuelling, the *Queen Elizabeth's* roughly two squadrons of F-35Bs would provide a small number of combat sorties per day and would have limited range and endurance compared to land-based fighters.

66 Pierre Tran, "Britain Flip-Flops toward ISR Drone, but France Keeps Eye on Combat Capability," *Defense News*, May 11, 2018.

67 IHS Jane's, "Lockheed Martin F-35 Lightning II," *Jane's All the World's Aircraft*, January 23, 2018.

FIGURE 22: ILLUSTRATIVE MAXIMUM PERFECT WORLD COMBAT RADIUS OF THE F-35B AND F-35A ASSUMING NO LOITER TIME OR COMBAT FUEL



Summary

The RAF, like other Western military services, is a far more lethal air force than it was 25 years ago. It is also substantially smaller. Decisions to reduce the RAF's size were based in part on the assumption that the end of the Cold War would lead to a decrease in operational demand for its forces; new weapon systems were likewise cancelled or delayed given the lack of competitors who could develop countervailing weapon systems. These assumptions have proven invalid. A decrease in operational tempo after the Cold War never really materialised, given the need for RAF forces to counter violent extremism in the Middle East and Afghanistan, as well as the need to enhance deterrence in Eastern Europe and elsewhere. The maturation of new weapons technologies over the last 25 years coupled with the more recent return of great power competition means the RAF should once again plan to operate its forces in contested environments.

The next chapter will address key strategic choices facing RAF planners as they determine how to best prepare the United Kingdom's future air forces to meet these challenges.

CHAPTER 3

Exploring the RAF's Strategic Choices

Chapter 3 summarises insights from the 2018 RAF Strategic Choices Exercise that assessed the emerging operating environment, potential capability trade-offs, and new investments that could help close the gap between the RAF's projected future force structure and its ability to support the United Kingdom's strategic priorities.

Overview of Strategic Choices Exercises

Strategic Choices Exercises provide a framework for defence strategists, policymakers, planners, operational experts, and budgeteers to collaboratively assess alternative strategies for an individual military service, a joint military force, or a national defence organisation. CSBA has led dozens of Strategic Choices Exercises to facilitate the evaluation of new operating concepts and alternative force structures to support national security strategies. Rather than build a budget and military from the bottom up, exercise participants first evaluate trends that should influence a military organisation's priorities over a ten-year period and then identify how its current plans and programmes could be reshaped using CSBA's proprietary Strategic Choices Tool (SCT). The Strategic Choices Tool includes a database of forces, capabilities, and potential acquisition programmes that players can choose to invest in or divest from over the ten-year planning period.⁶⁸

68 For more information on CSBA's SCT, see Jacob Cohn and Katherine Blakely, "A Powerful Tool for Defense Strategy and Budget Planning," factsheet, Center for Strategic and Budgetary Assessments, available at https://csbaonline.org/uploads/documents/CSBA__Strategic_Choices_Handout.pdf. For another example of a Strategic Choices Exercise involving U.S. think tanks in advance of the 2016 U.S. presidential election, see Jacob Cohn, Ryan Boone, and Thomas G. Mahnken, *How Much Is Enough? Alternative Defense Strategies* (Washington, DC: Center for Strategic and Budgetary Assessments, 2016).

Strategic Choices Exercises typically follow an iterative methodology:

- **Step 1: Frame priority challenges.** Strategic Choices Exercises are inherently about solving problems such as addressing strategic challenges posed by competitors and specific operational discontinuities created by the emergence of new threats or technological opportunities. Independent teams identify and prioritise key strategic and operational challenges, mission areas, and other trends that should influence an organisation's future plans and resource priorities.
- **Step 2: Identify strategic approaches.** Teams independently develop overarching strategies to rebalance a service or defence organisation's force structure and capabilities over a ten-year future planning period (e.g., 2019–2028). Teams' strategies consider changes needed to operating concepts for major mission areas and the broad characteristics (size and shape) of a future force that will be more capable of implementing a national defence strategy and addressing the challenges identified by teams during step 1. Teams consider major initiatives that range from changes in an organisation's force posture at home and abroad to altering the organisation's overarching concept for fighting major conflicts in the future.
- **Step 3: Rebalance to support a team's strategy.** Teams rebalance their organisation's force structure and capabilities over the ten-year planning period. Using the Strategic Choices Tool, teams invest in and divest from force structure and acquisition programmes to align with their strategic priorities.⁶⁹ Teams consider options that are part of an organisation's existing programme and alternative investments that are technologically and programmatically feasible but not currently funded. The objective of this step is to create a notional ten-year plan that will place an organisation on the path towards a future force that is better capable of supporting the objectives of a national security strategy.
- **Step 4: Iterate as necessary.** Participants share their strategies and resulting choices to develop an understanding of major trends and differences across teams. Successful exercises help participants visualise the future forces, capabilities, and costs associated with new and existing missions or ways of warfare in sufficient detail to enable follow-on discussion and analysis.

⁶⁹ Team rebalancing activities are broken into two 5-year moves. This two-move structure is modelled after the U.S. Department of Defense's Future Years Defense Program (FYDP) construct, which examines the upcoming year and the four years beyond it for decisional purposes. While exercises could have one or two moves of any length, most exercises are effectively two FYDPs out. Framed this way, it is often easier for participants to visualise the potential duration associated with development programmes and force generation. Taking multiple moves in this manner also stresses that force planning often incurs prerequisites (e.g., to stand up X force structure by 20YY, one must invest in Z capability now and begin associated training and construction activities).

Insights from the 2018 RAF Strategic Choices Exercise

Background and Objectives

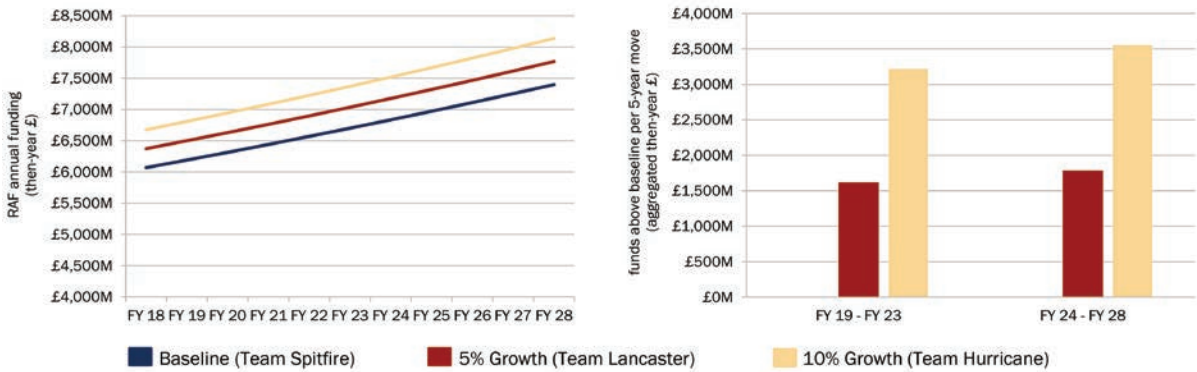
UK defence experts from a range of planning and operational backgrounds participated in a 2018 Strategic Choices Exercise to develop alternatives to the RAF's planned force structure and modernisation programmes over a ten-year period (2019–2028). The exercise leveraged participants' operational backgrounds and experience, as well as results from previously completed planning activities to identify major capability shortfalls and the potential for new concepts and advanced technologies to address them. The exercise's overarching objective was to generate actionable insights to inform the RAF's future planning. As an exploratory exercise, participants focused on operating concepts, capabilities, and capacities to address emerging threats; it was not a "budget drill."

Three teams of subject matter experts were each given the RAF's 2019–2028 planned force structure and modernisation programme baseline as a common starting point.⁷⁰ Teams were then tasked to retain or modify this baseline to address their desired strategic priorities, remedy shortfalls identified during other wargames and analyses, and exploit promising emerging technologies. Each team was provided with a different ten-year funding profile to create a basis for comparing the sensitivity of their choices to resource levels. One team (Team Spitfire) was given the RAF's projected 2019–2028 budget profile adjusted for inflation. A second team (Lancaster) was given the same profile plus a 5 percent funding increase, and the third team (Hurricane) used the baseline budget plus a 10 percent funding increase (see Figure 23).⁷¹

70 CSBA prepared this baseline from data presented in the MoD's annual *Equipment Plans*, its *Annual Reports*, and open source assessments of UK force structure. For force structure, CSBA frequently referenced both IHS Jane's defence analyses of UK Services and IISS, *The Military Balance* (2018). See MoD, *The Defence Equipment Plan 2018* (United Kingdom: MoD, 2018); and MoD, *Annual Reports and Accounts 2017–2018* (United Kingdom: MoD, 2018).

71 Not all Strategic Choices Exercises are structured this way. Alternative funding profiles are frequently the means with which to stress team decisions and do rudimentary sensitivity analysis of team decisions relative to resources. CSBA's SCT features *negative* funding growth just as frequently, if not more so, as positive funding growth to prepare decisionmakers for adversity. The clients of this particular Strategic Choices Exercise requested these funding levels because a) they felt the RAF already faced severe difficulty in meeting current or future missions; and b) they wanted to consider possible growth strategies with marginal additions enabled by extra potential funding.

FIGURE 23: TEAMS WERE GIVEN DIFFERENT TEN-YEAR BUDGET PROFILES



Insights into Major RAF Challenges

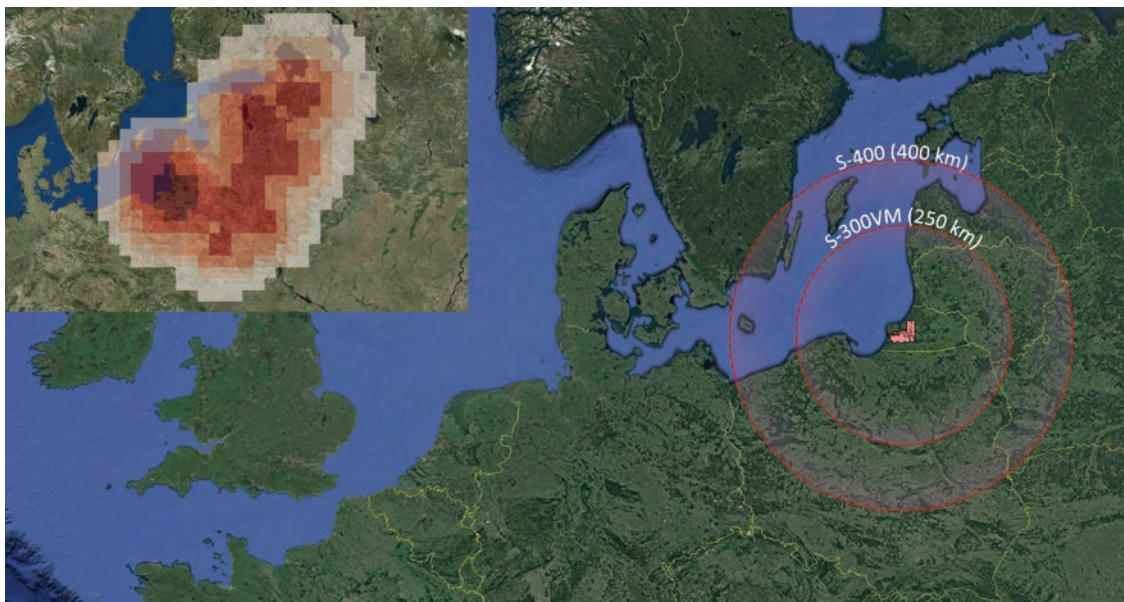
This section presents a compilation of insights from the 2018 Strategic Choices Exercise and other assessments on challenges and priority mission areas that should be considered by RAF planners.

Rise of A2/AD threats. Advanced IADS will challenge the RAF’s current concepts for conducting military operations. To counter NATO advances in aircraft and cruise missile capabilities late in the Cold War, the Soviet Union developed the S-300 SAM series (originally the NATO SA-10 Grumble, as well as advanced variants such as the SA-20 Gargoyle) to defend increasingly larger areas. After the Cold War, Russia developed the S-400 system (NATO SA-21 Growler) that is capable of employing a family of short-range missiles (9M96 variants with ranges of 40–120 km) and long-range weapons (the 48N6 with a range of 250 km and the 40N6 with a range of 400 km).⁷² Capable of setting up, firing, breaking down, and moving within short periods of time and defended by other weapon systems, the S-400 family of capabilities is intended to survive and fend off NATO airpower long enough for other Russian forces to achieve their objectives.

Russia’s deployment of highly lethal long-range SAMs should change the way NATO air forces plan to operate. When placed within the Russian exclave of Kaliningrad, S-400s will threaten NATO airpower operations in northern Latvia, southern Poland, and deep into the Baltic Sea. Figure 24 highlights both the ranges covered and the density of air defence systems that are postured in Kaliningrad and could be deployed to support a Russian military invasion of the Baltic states.

72 For more on Russian missile defense capabilities, see Keir Giles, *Russian Ballistic Missile Defense: Rhetoric and Reality* (Carlisle, PA: U.S. Army War College Press, 2015). The characteristics of Russian interceptors are outlined on p. 25.

FIGURE 24: ILLUSTRATIVE COVERAGE AND DENSITY OF RUSSIAN SAMS



To survive in this environment, UK and NATO non-stealth combat aircraft, air refuelling tankers, and AWACS will have to operate at greater distances from the battlespace. Further, Russia's IADS are backed by a network of radars and surveillance systems with multi-phenomenology data fusion that could give its air defence forces enough situational awareness to threaten 5th generation aircraft. Defeating these IADS and the other A2/AD systems they cover will require the RAF and its NATO partners to disrupt Russia's entire battle network.⁷³

Growing risk to large legacy platforms. It is unlikely that wide-body ISTAR aircraft will be able to operate within areas covered by advanced IADS and other air and missile defences.⁷⁴ The RAF's loss of its high-powered airborne sensors and battle management systems would result in a dramatic decrease to its battle network effectiveness. To address this challenge, the RAF should consider the utility of using networked unmanned aircraft and space assets as ISTAR nodes in future battle networks and alternative ISTAR and C2 concepts that will allow its warfighters to function effectively with less reliance on information and direction from second parties.

73 For more on the competition between and disruption of battle networks, see John Stillion and Bryan Clark, *What it Takes to Win: Succeeding in 21st Century Battle Network Competitions* (Washington, DC: Center for Strategic and Budgetary Assessments, 2015).

74 For more on how the operational environment across a range of potential scenarios is becoming increasingly contested, see Gunzinger, *Shaping America's Future Military*; Gunzinger, Clark, Johnson, and Sloman, *Force Planning for the Era of Great Power Competition*; and Luis Simón, "The 'Third' U.S. Offset Strategy and Europe's 'Anti-access' Challenge," *Journal of Strategic Studies*, 2016, p. 14.

A sustained high operational tempo is eroding the RAF's current and future readiness. The RAF has insufficient force structure capacity to meet current operational requirements and maintain a sufficient level of readiness to respond quickly to a major combat operation. The RAF has been hard-pressed to sustain enduring commitments in multiple regions, and the service life of its aircraft and munitions are wearing out faster than planned.⁷⁵ Further, budget cutbacks have led the RAF to reduce its end strength, which has resulted in shortages of key personnel and skillsets.⁷⁶ Fewer maintainers and a higher operational tempo (OPTEMPO) has resulted in a vicious cycle for sustaining RAF aircraft and other weapon systems. Funding for force structure recapitalisation and modernisation has been cannibalised to resource current operations. High demands imposed by day-to-day operations impede the RAF's ability to train for and potentially respond to a major combat operation such as a NATO Article V defence of an allied state. In short, under pressure to meet sustained deployment demands without commensurate budgetary relief, the RAF has been forced to mortgage its future to pay for the present.

The RAF has a significant shortfall in capacity. As presently constituted, the RAF lacks sufficient modernised force structure capable of operating in the contested environments that would exist during a NATO Article V operation against Russia. Air Chief Marshal Sir Stephen Hillier observed that to sustain current operations, the RAF must "thicken" its force structure and capabilities.⁷⁷ For instance, the RAF lacks sufficient capacity for counter-air missions. The RAF and other NATO air forces have grown accustomed to gaining air superiority with little effort and having sufficient time to build-up an overwhelming force in response to acts of aggression by lesser military powers. In a future NATO Article V response to defend an ally against Russian aggression, it is highly likely the RAF will have to operate in contested airspace and without the luxury of a long period of time to prepare and deploy to expeditionary airbases on the continent. Significant shortfalls in the RAF's counter-air capacity would serve to increase Russia's advantages in time and space, likely to the point that it would achieve its campaign objectives before a NATO coalition could respond effectively. The RAF's recent divestment of maritime patrol aircraft is another example of a gap in its ability to meet its joint obligations.

Insufficient mass for emerging challenges. Conflict with a great power will require the RAF to possess two forms of mass: the ability to mass sufficient strike weapons in space and time to overcome enemy precision defences and a sufficient mass of aircraft, aircrew, and maintainers

75 To cite an example, the RAF is utilising the Typhoon at roughly twice the rate of other Typhoon operators and is investigating the feasibility of extending the Typhoon's fatigue life beyond the current 6,000 flying hour limit. See Andrew Doyle, "UK Looks to Extend Eurofighter Typhoon's Fatigue Life," *FlightGlobal*, August 26, 2009.

76 Comptroller and Auditor General, *Ensuring Sufficient Skilled Military Personnel* (United Kingdom: National Audit Office, April 13, 2018), pp. 18–25.

77 "Plane Speaking with: ACM Sir Stephen Hillier," *Royal Aeronautical Society*, March 27, 2018, available at <https://www.aerosociety.com/news/plane-speaking-with-acm-sir-stephen-hillier/>.

to sustain combat operations for an extended period of time and offset attrition.⁷⁸ Laser-targeting, GPS, or active seekers combined with other supporting battle network capabilities, like the E-3D Sentry airborne early warning and command and control aircraft or space-based reconnaissance and surveillance, have enabled progressively fewer aircraft to engage increasing numbers of targets on a single sortie. The RAF will need to allocate more aircraft, strike sorties, and weapons against enemies prepared to engage the RAF's entire kill chain, including its airborne ISTAR and battle management enablers.⁷⁹ Threats to RAF kill chain capabilities and operations, combined with future great power target sets that could be far larger than post-Cold War air campaign target sets, mean that the United Kingdom and its allies will need more mass—strike aircraft, weapons, and their enablers—than are now in their air forces.

PGM capabilities and capacity. The United Kingdom lacks sufficient numbers of advanced PGMs to support a major operation against a great power aggressor. The UK military expended a significant portion of its PGM stocks during strikes in 2011 against targets in Libya, which was a far smaller and far more permissive environment than what would be expected in an Article V scenario against Russia.⁸⁰ The UK, U.S., and other NATO militaries are not procuring enough PGMs for even a limited conflict against a great power. Moreover, an Article V scenario will likely place a particularly high demand on survivable, penetrating strike weapons (including hypersonic weapons) to strike time-critical targets; weapons with enough standoff range to reduce risk to their launch aircraft; and weapons with built-in countermeasures against enemy PGM defences.

Need to regain freedom of action in the EMS. U.S. and allied military successes in the 1991 Gulf War rested on their ability to exploit their dominance of the EMS to find and strike Iraqi forces with near impunity. Recognising this, the Russian and Chinese militaries have developed information warfare strategies to paralyze the ability of adversary militaries to gather information, determine the best course of action, and act decisively. To compete successfully with great powers, the United Kingdom, United States and other NATO states should regain the initiative in the EMS by harnessing new concepts and technologies such as lower-power stand-in jammers, passive sensors, and agile multifunctional and networked EW systems.

Increasing missile threats to homeland and expeditionary bases. The United Kingdom is not safe from kinetic and non-kinetic attacks by a great power adversary. In Syria, Russia has already used long-range aviation assets like the Tu-160, air-launched cruise missiles like the

78 The RAF has suffered minimal attrition in the nearly three decades since the end of the Cold War. For example, only seven Tornados were shot down during Desert Storm in 1991. It may sustain several times this number in a single day of high-intensity conflict. Data on aircraft combat losses is based on research from another CSBA study: see John Stillion, *Trends in Air-to-Air Combat: Implications for Future Air Superiority* (Washington, DC: Center for Strategic and Budgetary Assessments, 2015).

79 For more on how precision defenses drive up requirements for munitions and strike aircraft, see Gunzinger and Clark, *Sustaining America's Precision Strike Advantage*.

80 Karen DeYoung and Greg Jaffe, "NATO Runs Short on Some Munitions in Libya," *The Washington Post*, April 25, 2011.

Kh-101, and sea-launched cruise missiles like the Kalibr.⁸¹ Russia has developed air-launched and ground-launched land-attack cruise missiles (LACMs) that could reach targets located throughout the UK.⁸² Future RAF expeditionary bases on the continent and elsewhere will be susceptible to LACM, SRBM, electronic warfare, and cyber attacks.

The RAF lacks sufficient active and passive air and missile defences to counter these threats. Shortfalls in air and missile defence capacity could leave the RAF's main operating bases in the homeland so vulnerable that even a small missile attack could inflict significant damage. The closure and consolidation of RAF airbases could magnify this problem, since it could enable an attacker to better concentrate its strikes against a smaller number of targets. The RAF should assess its critical base vulnerabilities and take steps to harden them against kinetic and non-kinetic attacks. Additional investments in hardening, dispersal, base recovery capabilities, and kinetic and non-kinetic air and missile defences could reduce the attractiveness of opportunistic strikes and, most importantly, keep the RAF in the fight even after an enemy has landed a punch. While it is impossible to defend against all possible threats, a prudent and affordable combination of capabilities could enhance its base resilience and ability to sustain offensive operations. Higher capacity air and missile defences could also drive up an enemy's cost to successfully attack RAF bases, possibly to the point where it would choose to attack other, less-defended targets.

More resilient space-based capabilities. The United Kingdom is dependent on space-based communications; positioning, navigation, and timing provided by satellites; and remote-sensing to coordinate operations across the Joint Force. Recognising the importance of space-based capabilities for military operations, potential adversaries are developing kinetic and non-kinetic means of temporarily or permanently denying the use of these systems.⁸³ To ensure its operations are not severely impeded by these threats, NATO will need to improve the resilience of its space-based capabilities and develop non-space-based alternatives.

Insufficient resources for training. Superior training has been a traditional strength of the RAF. This said, insufficient resources for training, developing new operating concepts, and instilling the warfighting ethos necessary for high-intensity warfare is reducing the RAF's readiness. In addition to more resources for training, the RAF should update its training practices to account for the changing nature of warfare. In particular, control over and use of the electromagnetic spectrum (EMS) will be critical to RAF operations in high-intensity combat operations. One option would be for the RAF to develop and implement

81 Dave Majumdar, "Russia Boasts of Using 215 New Weapons Systems in Syria," *War is Boring*, February 1, 2018.

82 Bureau of Arms Control, Verification, and Compliance, "INF Treaty: At a Glance," *U.S. Department of State*, December 8, 2017; and Pavel Podvig, "Is It Too Late To Have an Informed Discussion about the INF Treaty?" *Russian Strategic Nuclear Forces*, July 1, 2017.

83 For more on the development of counter space capabilities, see Brian Weeden and Victoria Samson, ed., *Global Counterspace Capabilities: An Open Source Assessment* (Washington, DC: Secure World Foundation, 2018); and Daniel Coats, *Statement for the Record: Worldwide Threat Assessment of the U.S. Intelligence Community* (Washington, DC: Office of the Director of National Intelligence, 2018) p. 13.

Live-Virtual-Constructive training to allow its personnel to train in a realistic virtual environment that replicates the electromagnetic environments of future battlespaces.⁸⁴

Changes in the defence industrial base. The United Kingdom's defence industrial base cannot surge quickly enough to produce major military systems and critical expendables like PGMs to match the accelerated pace of modern warfare.⁸⁵ In many cases, key components or even entire systems are produced outside of the United Kingdom. Absent a clear, long-term commitment to increased procurement spending, its defence industrial base will not be incentivised to increase its productive capacity, and the UK will remain unable to cope quickly with demand shocks. This will require the MoD and its services to provide clear and unified information to the industrial sector on its future priorities. This includes requirements for new technologies that establish the right balance between affordability and the potential to increase military capabilities and capacity. The United Kingdom must also be able to compete amidst the accelerating development and fielding of new technologies by sophisticated adversaries. From the RAF's perspective, this will require processes that provide greater agility and flexibility to manage the growing pains of new weapons systems earlier in their service lives and incrementally improve their performance throughout their lifecycles to maintain relevance in future fights.

Insights into Future Priority Mission Areas

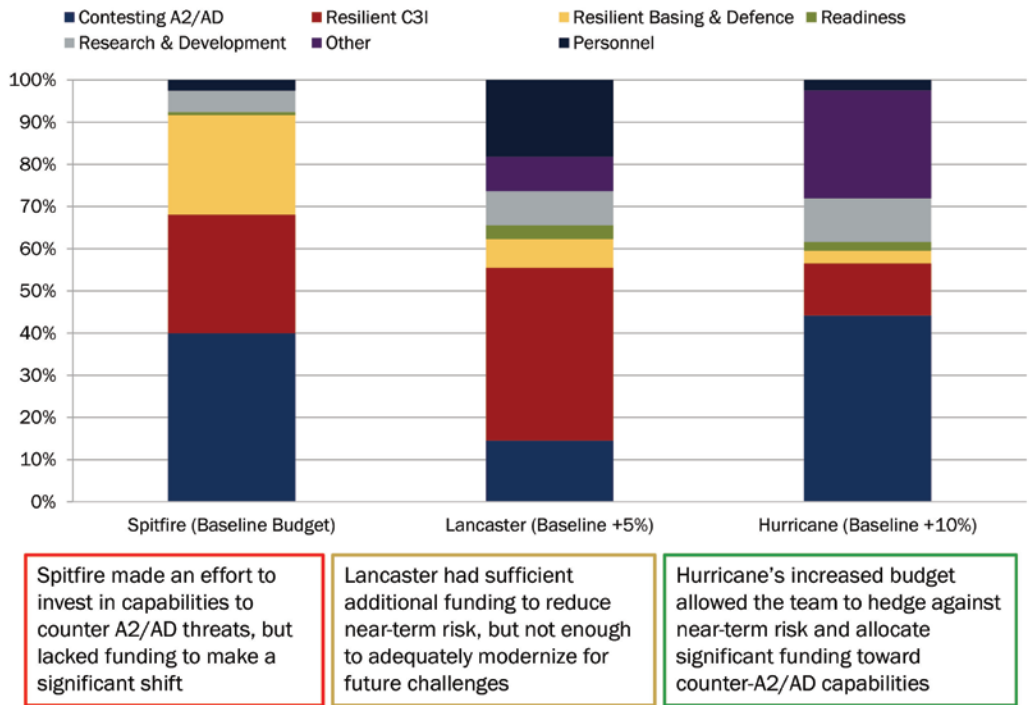
Homeland defence, protecting overseas territories against attacks, supporting the United Kingdom's strategic at-sea deterrent and warfighting at scale are enduring missions that should continue to drive the RAF's plans and programmes. New investments in these areas would help prepare the RAF to support NATO and other partners in long-term competitions that include deterring or responding to acts of aggression that fall short of war. These investments should include funding for capabilities to counter A2/AD threats. The RAF has an opportunity to become the force of choice for suppressing A2/AD weapon systems during a NATO Article V response. Interoperability with the U.S. military, independent access to

84 To compete effectively in a contested electromagnetic environment, operators must first be able to visualise the virtual battlespace they are operating in. A battle management system that maps and classifies the complex signals surrounding them and mimics a contested electromagnetic spectrum is a necessary precursor for a realistic, high fidelity training environment. Cyber operators confront similar challenges and have a comparable battle management and training requirement. For more on the necessity of an effective battle management system and a realistic virtual training environment, see Sydney J. Freedberg Jr., "Show Me the Battle: Cyber Command Needs Data Fusion, Training Sims & C2," *Breaking Defense*, November 14, 2018. For a description of the general characteristics of Live-Virtual-Constructive training environments, see Office of Naval Research, "Live, Virtual and Constructive (LVC) Training Fidelity," *ONR BAA Announcement #11-005*, 2011. For more on Live-Virtual-Constructive training, see Jennifer McArdle, *Victory Over and Across Domains: Training for Tomorrow's Battlefields* (Washington, DC: Center for Strategic and Budgetary Assessments, 2019).

85 Sabine Siebold and Andrea Shalal, "German Halt in Saudi Arms Sales Causing Serious Problems—Airbus," *Reuters*, February 15, 2019; and M. J. Williams, "Implications for British Defense Dependency on Foreign and Security Policy," in *Operations in Libya: Ninth Report of Session 2010-12*, Volume II, *Additional Written Evidence* (London: House of Commons Defence Committee, February 2012), available at <https://publications.parliament.uk/pa/cm201012/cmselect/cmdfence/950/950vww.pdf>.

sources of innovation, a legacy of professionalism and world-class talent, geographic proximity to potential conflict zones, and a traditional leadership role within NATO all suggest that the RAF could evolve to fulfil this role—if furnished with the necessary resources. Transitioning the RAF to perform as a counter-A2/AD force of choice would address key allied capability shortfalls and bolster NATO’s deterrence posture, as well as gain the UK a position of influence within a coalition and as the partner of choice. It would also better prepare the UK’s Joint Force to suppress A2/AD challenges in other, potentially non-NATO conflict scenarios. Figure 25 provides a breakout of investments made by the RAF Strategic Choices Exercise teams in capabilities and technologies for countering A2/AD complexes.

FIGURE 25: TEAM INVESTMENTS IN CAPABILITIES TO COUNTER A2/AD



Insights on future force structure and capability priorities

This section outlines key force structure and capability priorities that should guide the RAF’s modernisation as it focuses on its key mission areas. These enhancements would improve the RAF’s ability to defend the homeland and project air power early in a conflict against a great power aggressor.

Increase the range and mass of the RAF’s precision strikes into contested areas. The future RAF should be able to mass sufficient firepower in time and space to overwhelm the capacity of adversary A2/AD networks. Combat mass can be generated by increasing its capacity of advanced platforms capable of penetrating and attacking enemy defensive networks. Near-term options include procuring the F-35A and modernising its 4th generation fighters.

Delaying planned F-35B procurement to procure a number of F-35As would give the RAF's combat air forces increased range and a wider choice of payloads. This could entail slowing, but still completing, the planned procurement of F-35Bs in order to fully support the UK's carrier requirement. The near-term savings realized by slowing F-35B procurement could help fund the procurement of less expensive F-35As.⁸⁶ For example, the RAF could delay the procurement of roughly ten F-35Bs and use those funds to procure roughly 13 F-35As.

Investments in additional strike platforms should be complemented by increases in PGM stockpiles to mitigate existing shortfalls and prepare for future crises that may occur with little or no prior warning. Rather than simply buy larger numbers of today's PGMs, the RAF's future munitions inventory should include next-generation standoff weapons and hypersonic weapons. These weapons would enable modernised 4th generation fighters to contribute to the early fight by launching attacks into contested areas while remaining out of range of enemy IADS. F-35s with their advanced sensing and data-fusion capabilities could provide target cueing for these standoff attacks.

Finally, the RAF could increase its combat mass by investing in low-cost, expendable UAVs capable of conducting a range of missions such as strike, ISR, and electronic attack over long ranges and into contested areas. The survivability of any individual UAV may be low, but en masse, attritable UAVs could generate effective combat mass by overwhelming the capacity of advanced defences.

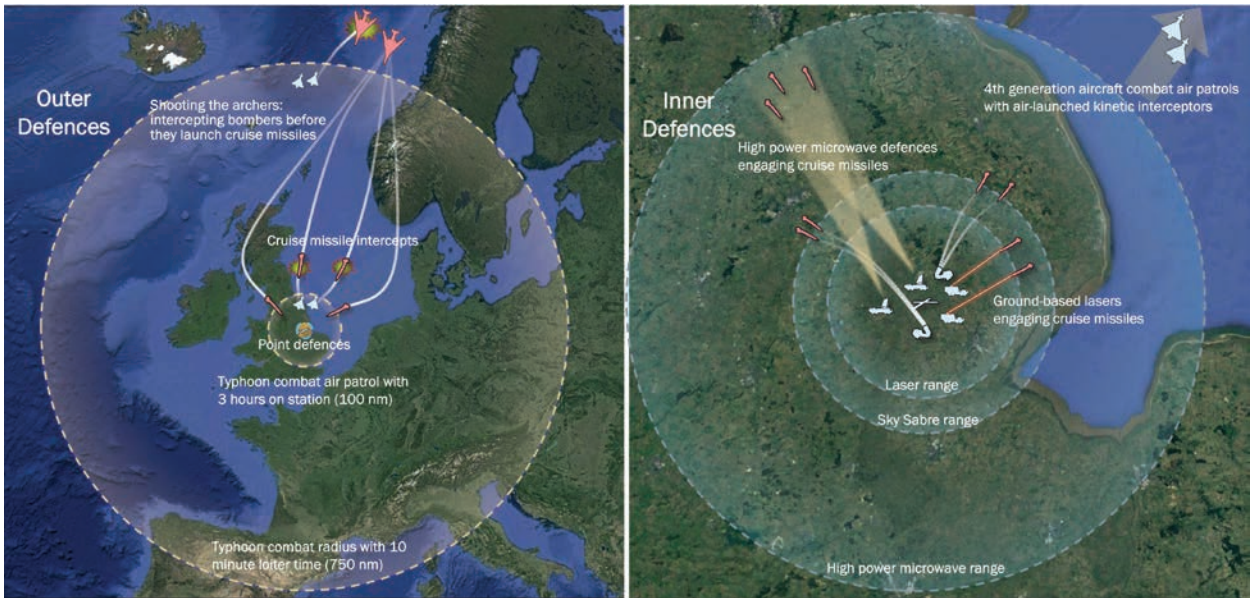
Improve homeland defence and RAF base resilience. The RAF should invest in additional kinetic and non-kinetic air and missile defences to protect the homeland and RAF main operating bases. Directed energy weapons such as high-energy lasers and high-power microwaves could be important components of a future air and missile defence architecture (see Figure 26). These weapons could be capable of engaging multiple threats in an enemy salvo and could provide sustainable defensive capacity over time for a lower cost per engagement compared to current generation surface-to-air interceptors.⁸⁷

The RAF could leverage years of directed energy research to develop more effective and efficient air and missile defence capabilities to improve homeland defence and base resilience against salvos of missiles; guided rockets, artillery, mortars, and munitions (G-RAMM); and other threats. Directed energy weapons alone are insufficient for base defence, but the low cost per shot and large magazine depth of such weapons make them critical components of future air and missile defence networks.

86 An F-35A is over \$30 million less expensive than a F-35B. Their unit costs can be calculated based on data in the procurement justification books of the U.S. 2019 budget request. See Office of the Under Secretary of Defense (OUSD) (Comptroller)/Chief Financial Officer (CFO), *Department of Defense Fiscal Year 2019 Budget Request: Aircraft Procurement, Navy*, vol. 1-29 (Washington, DC: DoD, February 2018); and OUSD(C)/CFO, *Department of Defense Fiscal Year 2019 Budget Request: Aircraft Procurement, Air Force*, vol. 1-1 (Washington, DC: DoD, February 2018).

87 For more on the utility of DEW in base defence, see Rehberg and Gunzinger, *Air and Missile Defense at a Crossroads*.

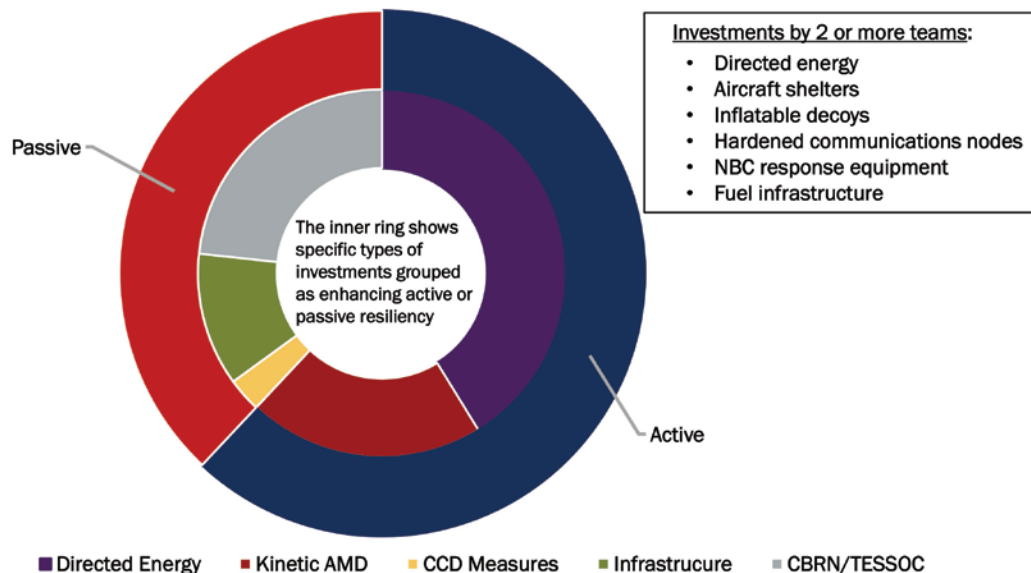
FIGURE 26: NOTIONAL FUTURE DEFENCE AGAINST MISSILE SALVOS



Active defences should be supplemented by passive defences that include hardened aircraft shelters; dispersing major base equipment and facilities; and camouflage, concealment, and deception (CCD) measures to complicate an attacker's intelligence collection, planning, and targeting. Future base defences could be enabled by modern airborne sensors that would help increase the range at which incoming threats could be identified and engaged.

While perfect defences against the strike capacity of a great power adversary is impractical and unaffordable, the RAF should field sufficient defences in the homeland to counter small demonstration raids of ballistic missiles or cruise missiles. Deploying ballistic missile and other ground-based air defence systems in the United Kingdom would help deter air and missile attacks against the homeland. A combination of active and passive defences could increase the level of effort an attacker must exceed to ensure a given level of success. This could force an enemy to choose between not wasting its resources or launching strikes that are so massive that they would be highly escalatory in nature. More robust air and missile defences would also improve the RAF's ability to quickly generate and project combat power from its homeland bases in the opening stages of a conflict on the continent.

FIGURE 27: WEIGHT OF STRATEGIC CHOICES EXERCISE TEAMS' INVESTMENT IN DIFFERENT HOMELAND DEFENCE AND BASE RESILIENCE CAPABILITIES



Note: CBRN/TESSOC stands for Chemical, Biological, Radiological, and Nuclear/Terrorism, Espionage, Subversion, Sabotage, and Organised Crime

Increase the coverage, endurance, and resilience of airborne and space-based ISR networks.

The RAF should consider investment alternatives for airborne early warning and command and control (AEWC2), space resilience, and maritime surveillance systems as it modernises its ISR networks for operations in contested environments.

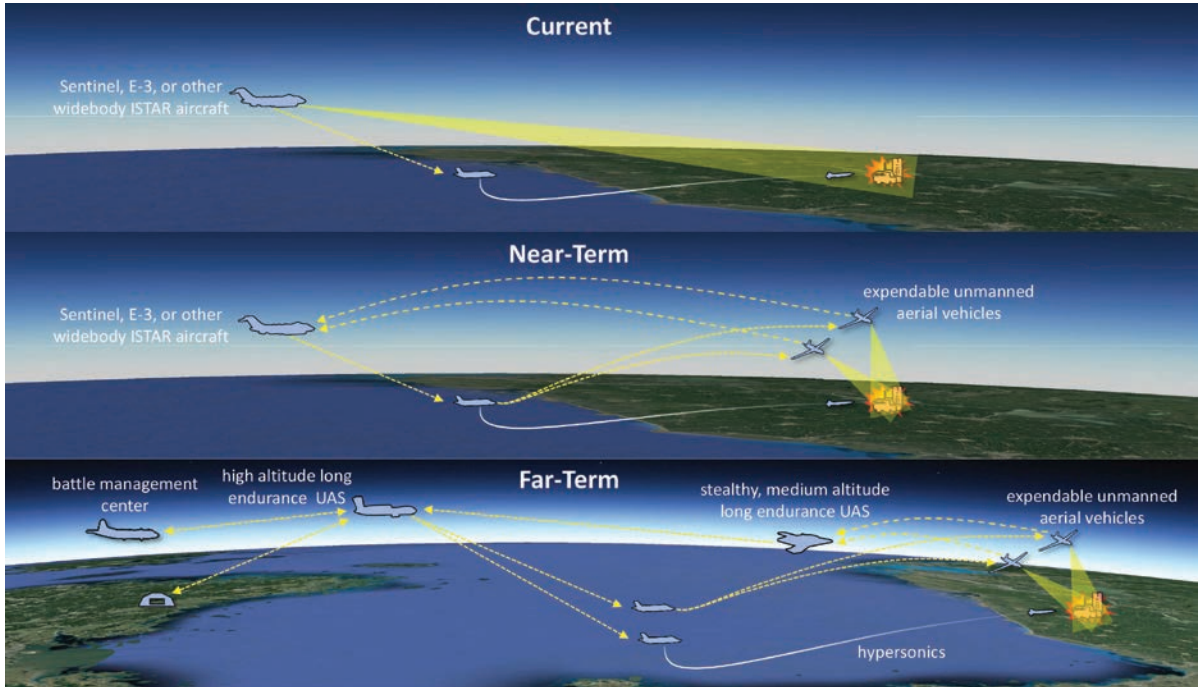
The RAF's widebody E-3 AWACS cannot survive in contested airspace, are old, and are expensive to operate. The RAF could replace its E-3s with a modern, less expensive means of providing AEWC2 to support power-projection operations and homeland defence. Alternative future architectures might include unmanned networked stealth systems as well as rapidly deployable microsatellite constellations. Unmanned systems and rapidly deployable microsatellite constellations, such as a follow-on to the Carbonite-2 programme, could serve as networked ISTAR and communications nodes. There could still be a role for manned battle management centres, and, depending on the architecture and the numbers and types of systems procured, a future approach could disaggregate the current concentration of capability in high-value widebody aircraft to a far larger number of aircraft and satellites performing different functions (see Figure 28).

Maritime surveillance is once again an essential mission for the RAF. Russian submarines are patrolling the Atlantic Ocean at levels not seen since the Cold War.⁸⁸ The RAF should recon-

88 Scott Wyland, "Russian Submarines Are a Growing Threat, Says Europe's Top Navy Commander," *Stars and Stripes*, June 20, 2018.

stitute its capabilities to surveil maritime approaches to the United Kingdom, patrol the GIUK gap, strengthen Royal Navy anti-submarine efforts, and support allied nations.

FIGURE 28: THE POSSIBLE EVOLUTION OF BMC2 OPERATIONS IN CONTESTED AIRSPACE



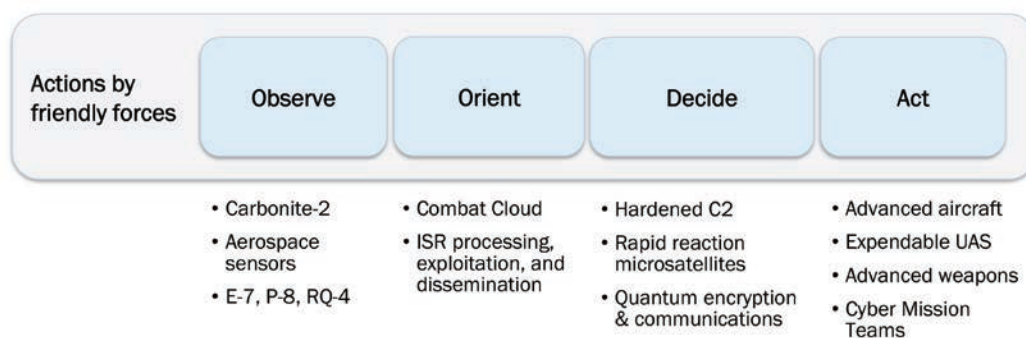
Take advantage of emerging technologies. To shape itself into a force of choice for countering A2/AD challenges, the RAF should increase investment in advanced weapons such as survivable, penetrating cruise missiles (including hypersonic) for strikes, next-generation air-to-air weapons, new sensors, and electronic warfare systems (see Table 2). The RAF should also continue funding for its next-generation fighter, with an emphasis on systems integration (both on the platform and offboard) and a modular, upgradeable architecture. Spiral upgrades to major weapons systems could help ensure S&T initiatives rapidly transition to operational capabilities.

TABLE 2: TEAM RESEARCH AND DEVELOPMENT PRIORITIES

R&D funded by at least two teams	R&D funded by all three teams
<ul style="list-style-type: none"> • Rapid reaction microsats • Advanced aerospace sensors • Advanced cyber capabilities • Advanced electronic warfare systems 	<ul style="list-style-type: none"> • Advanced weapons (including hypersonic) • ISR Processing, exploitation, & dissemination • Carbonite-2 follow-on • Combat cloud • Directed energy

Information is the lifeblood of modern warfare. The future RAF should have the ability to maintain end-to-end information superiority, get inside an adversary's decision-making cycle, and ultimately achieve decision dominance. To achieve these objectives, the RAF should increase research and development funding for machine learning; artificial intelligence; quantum technology; advanced aerospace sensors; more resilient battle management command, control, and communications (BMC3); full spectrum targeting; faster ISR processing, exploitation, and dissemination (PED); and information security (see Figure 29).

FIGURE 29: TEAM SELECTIONS FOR DECISION SUPERIORITY CAPABILITIES






Reassessing air mobility forces and joint enablers. The RAF has substantial air mobility fixed-wing and rotary-wing forces that are linked to Army deployment requirements. Air mobility capacity is often seen as a limiting factor as to how quickly the UK military can deploy its Joint Force. Response speeds will be critical to preventing Russia from achieving a *fait accompli* in a future NATO Article V scenario. In that context, heavy land forces would be most useful if they are already based on the continent. Funding expended to sustain these air mobility capabilities cannot be used to develop and field RAF weapons systems capable of penetrating A2/AD environments to provide air support to NATO manoeuvre forces. Modest divestments of the RAF's air mobility aircraft could help fund counter-A2/AD capabilities that would allow it to more quickly suppress enemy IADS and provide air support to friendly land forces. Some air mobility platforms should be retained, however, to support NATO missions and ensure a sovereign capability to deploy and sustain forces globally.

Insights on How Quickly the RAF Could Shift Its Priorities

Table 3 is a round-up of major choices made by the three 2018 RAF Strategic Choices Exercise teams. The teams provided the following insights on how quickly the RAF may be able to shift its plans and programmes to better prepare for operational challenges identified in this report given different funding levels over a ten-year period (FY 2019–2028).

TABLE 3: SELECTED FORCE STRUCTURE STRATEGIC CHOICES BY TEAM

	2028 Baseline Forces	Team Spitfire 	Team Lancaster 	Team Hurricane 
Combat Air	186	+10		+40
C3ISR (manned, no space)	45	-2	-6	+7
Widebody UAVs	20	-10	+20	
Expendable UAVs	None	+700		+200
Aerial Refuelling	14			+12
Airlift	44	-2	-14	-14
Space	None	+80	+3	+55

Team Spitfire: RAF baseline budget projected through 2028. Team Spitfire focused on improving the RAF's future capabilities and capacity to support its core missions and create a NATO force of choice for countering A2/AD networks. Without additional resources, however, the team believed that the RAF's transformation towards a force better capable of supporting a NATO Article V scenario against a great power aggressor would be significantly delayed. The team determined that while its budget profile was sufficient to fund investments in key technologies, platforms, weapons, and other advanced systems, it would not procure enough combat mass to accelerate the RAF's initial response in such a crisis.

Team Lancaster: RAF baseline budget through 2028 +5 percent growth. Team Lancaster assessed that the RAF currently lacks excess capacity for any of its enduring mission areas. Consequently, it avoided force structure divestments that would increase near-term operational risk. Additional funding above baseline enabled the team to take proactive actions to improve the RAF as a deterrent force. The team conceded their future force would still lack the ability to achieve escalation dominance relative to potential great power competitors. Instead, the team made substantive changes to the RAF's ISTAR recapitalisation plan to bolster its future resilience and better provide ISR and other critical support to NATO in an Article V response. Similar to the baseline budget team, however, Lancaster did not believe their rebalanced future (2030) force would be capable of significantly accelerating major offensive operations against a great power aggressor.

Team Hurricane: RAF baseline budget through 2028 +10 percent growth. With the largest budget increase, Team Hurricane funded force structure and capability investments to significantly accelerate the RAF's shift towards a future force better capable of deterring great power aggression. More specifically, the team felt their investments would provide sufficient capabilities, capacity, and readiness to help blunt a potential Russian offensive into the Baltic states within the first 72 hours. The team also thought their revised defence plan would improve RAF capabilities to conduct punitive strikes into A2/AD environments. Increasing the RAF's ability to punish an aggressor early could change an aggressor's risk calculus and degrade its

ability to control any territory it has invaded. Unlike the two exercise teams with lower budget profiles, Hurricane assessed its future force would be capable of accelerating a NATO counter-offensive against a great power aggressor.

Summary

The 2018 RAF Strategic Choices Exercise was an exploratory attempt at gauging how different budget top lines could impact the RAF's future plans and resource priorities. Exercise participants believed that the RAF has been underfunded for the current missions it is routinely asked to undertake, let alone what it may be asked to do in the future on behalf of the United Kingdom or NATO as a whole. This exercise should not be construed as recommending a specific budget top line for the RAF. It does, however, suggest that increased funding could help the RAF transition into a force of choice for overcoming A2/AD challenges; it also highlights the capabilities and capacities necessary for that transition. This would enhance NATO's ability to deter grey zone aggression and enhance its ability to quickly respond to a major security crisis. In summary, participants believed the exercise helped identify future challenges, priority mission areas, and alternative force structures and capabilities that should be considered as the RAF plans for a renewed era of great power competition.

CHAPTER 4

Towards a Force Planning Construct for the RAF

This chapter builds on preceding chapters to describe a candidate force planning construct (FPC) that could help guide development of the future RAF.

Force planning constructs are used to define the number, types, and frequency of operations a military should be sized and shaped to support in the future.⁸⁹ They articulate critical planning assumptions, operational concepts, and key scenarios that help guide future military modernisation and translate a defence strategy into resource priorities. For example, in 1989 the U.S. Chairman of the Joint Chiefs of Staff General Colin Powell recommended shifting from a force designed for global conflict with the Soviet Union to one that could respond to regional crises. He also recommended shifting the U.S. military posture in Europe from a force that was sized to defeat Soviet aggression to a much smaller one to reassure allies and deter lesser aggressors. The FPC inherent in Chairman Powell's thinking was intended to rationalise projected U.S. post-Cold War force cuts and avoid the creation of a hollow force similar to that which occurred during the U.S. post-Vietnam defence drawdown.⁹⁰

Periodic revisions to U.S. FPCs tend to occur in tandem with the development of new defence strategies. The U.S. 2018 *National Defense Strategy* outlined an FPC that is focused on defeating aggression by a great power, deterring opportunistic aggression elsewhere, deterring nuclear and non-nuclear attacks against the homeland, and disrupting imminent terrorist threats.⁹¹ The United Kingdom has followed a similar methodology of developing new defence

89 For more on force planning constructs and for recommendations on a future DoD force planning construct, see Gunzinger, *Shaping America's Future Military*; Gunzinger, Clark, Johnson, and Sloman, *Force Planning for the Era of Great Power Competition*.

90 Lorna A. Jaffe, *The Development of the Base Force 1989-1992* (Washington, DC: Office of the Chairman of the Joint Chiefs of Staff, July 1993), pp. 16–19.

91 DoD, *Summary of the 2018 National Defense Strategy*.

strategies and FPCs together. The seven most recent defence reviews and inherent FPCs are summarised in Table 4.⁹²

TABLE 4: KEY ELEMENTS OF RECENT UK MOD FORCE PLANNING CONSTRUCTS

	1981 Nott Review	1990 Defence Review	1994 Defence Costs Study	1998 & 2002 SDR	2003–2004 Defence White Paper	2010 SDSR	2015 SDSR
Force Planning Construct	The Way Forward	Options for Change	Front Line First	Expeditionary Force	Coalition Warfare	A New Approach	A Secure and Prosperous UK
Major Elements	Homeland defence + Nuclear deterrent + NATO Article V scenario + Out-of-area operations to extent resources permit	Homeland defence + Nuclear deterrent + NATO contribution + Smaller-scale expeditionary contingencies	Homeland defence + Nuclear deterrent + NATO contribution + Smaller-scale expeditionary contingencies	Homeland defence & provide support to civil authorities + Nuclear deterrent + 2 Joint Rapid Reaction Forces of up to 15,000 personnel each	Homeland defence & provide support to civil authorities + Nuclear deterrent + Up to 3 concurrent small-to-medium- scale operations	Homeland defence & provide support to civil authorities + Nuclear deterrent + 1 enduring stabilization operation + 2 non-enduring interventions	Homeland defence & provide support to civil authorities + Nuclear deterrent + 1 large-scale expeditionary operation of up to 50,000 personnel
					Or 1 large-scale operation + 1 small-scale operation	Or 3 non-enduring operations Or 1 large-scale intervention of up to 30,000 personnel	Or Numerous smaller-scale expeditionary operations
Key Points or Changes	<ul style="list-style-type: none"> Sustain air & land forces in continental Europe Royal Navy surface fleet cut to sustain maritime air & submarines in defence of NATO's flanks Expeditionary operations primarily as part of NATO coalition 	<ul style="list-style-type: none"> Capability-based rather than threats-based policy Managing cuts necessitated by downwards pressure on defence budget 	<ul style="list-style-type: none"> Maintain front line operational effectiveness Streamline management and command structures Outsource to private sector Rationalise command, training, and support structures 	<ul style="list-style-type: none"> Pivot from conventional large-scale war to rapidly deployable, flexible expeditionary capability Project power globally Focus on asymmetric warfare and international terrorism 	<ul style="list-style-type: none"> Armed Forces face broader range of tasks across wider geographical area Number of concurrent operations expected to increase Prioritise interoperability with allies 	<ul style="list-style-type: none"> More coherent, integrated approach to security across whole of government Greater emphasis on soft power and conflict prevention 	<ul style="list-style-type: none"> Commitment to "full spectrum" approach Resurgence of state-based threats Erosion of rules-based international order
Context	<ul style="list-style-type: none"> Soviet invasion of Afghanistan Economic downturn 	<ul style="list-style-type: none"> Falklands War Collapse of Soviet Union Peace dividend 	<ul style="list-style-type: none"> Gulf War Bosnia Kosovo Sierra Leone 	<ul style="list-style-type: none"> 9/11 attacks 	<ul style="list-style-type: none"> Multiple, concurrent expeditionary operations 	<ul style="list-style-type: none"> Post-war budget and force structure cuts Prepare for future challenges 	<ul style="list-style-type: none"> Russian annexation of Crimea Counter-ISIS campaign

92 For more on post-World War II defense reviews, see Claire Mills, Louisa Brooke-Holland, and Nigel Walker, *A Brief Guide to Previous British Defence Reviews* (London: House of Commons Library, 2018).

A Candidate Force Planning Construct for the RAF

The RAF's ability to exercise its core missions are challenged by the rise of revisionist great powers.⁹³ A new force planning construct could help guide the RAF's development of a future force with the right mix of capabilities and sufficient capacity to address these challenges. The concept should also address enduring commitments, such as homeland defence, that demand a sustained level of support over time in addition to temporary force structure "surges" to support operational requirements that would be additive to the requirements for pacing scenarios. Table 5 outlines a candidate construct for the RAF that builds on insights highlighted in this report.

TABLE 5: NOTIONAL FUTURE FORCE PLANNING CONSTRUCT FOR THE RAF

Primarily Size and Shape the RAF for Major Mission Areas/Pacing Scenario(s)	Examples
Support to a single major NATO Article V conflict on the continent	<ul style="list-style-type: none"> A major Article V conflict to defend or secure the sovereignty of a NATO Eastern European ally against a great power aggressor; the conflict could begin with great power sub-conventional grey zone aggression that then escalates to a major conventional conflict
Defence of the homeland	<ul style="list-style-type: none"> Sustained air sovereignty operations Limited missile defence operations to protect the homeland and improve the RAF's ability to project power from UK bases to support a major operation on the continent Surveillance operations to help protect the homeland's maritime approaches
Support to strategic deterrence	<ul style="list-style-type: none"> This mission area would encompass capabilities provided by the RAF to support the United Kingdom's at-sea strategic deterrent
Then stress test the resulting force against other enduring missions	Examples
Support to lesser conventional conflicts	<ul style="list-style-type: none"> Countering conventional aggression by a regional military power
Support to long-term deterrence operations	<ul style="list-style-type: none"> Includes a level of effort to deter or counter peacetime grey zone aggression in Europe that falls short of outright conflict
Support to long-term counter-terror operations	<ul style="list-style-type: none"> A level of effort to sustain multiple small and possibly widely dispersed counter-terror operations

Note: Blue shaded rows indicate principal mission areas that should primarily size and shape the force; white rows indicate other lesser mission areas that are nonetheless important to consider in determining the necessary portfolio of capabilities the force should have the ability to employ.

Pacing Scenario: Major Conflict with a Great Power Aggressor

FPCs include illustrative planning scenarios for potential future operations that can be used by planners and programmers to assess a military organisation's future capability and capacity requirements. It is unrealistic to assume that the RAF or any UK military service will have sufficient resources to equally support every possible conflict scenario. The U.S. military

93 Stephen Hillier, "RAF Must Modernise to Combat Growing Threat from Russia," *The Telegraph*, March 31, 2018.

services have each identified “pacing” scenarios that will best stress their individual mix of forces and capabilities. Major conflicts set in the Indo-Pacific and Europe are considered pacing scenarios by the U.S. Air Force.

Ideally, an RAF force planning construct should address scenarios that will have the most significant impact on the shape and size of its forces in the long term as well as the most likely scenarios in the near and mid-term. The most significant long-term challenges are likely to stem from scenarios for great power conflict in Eastern Europe coupled with attacks on the UK homeland. In contrast, the most likely near- and mid-term scenarios are continued counter-terror operations that require a continuous level of effort or a conflict with Iran or another rogue state. To provide a baseline to assess requirements for the future RAF, FPC pacing scenarios should also allow RAF planners to consider trends in the security environment and emerging technologies that could change the balance in key military competitions. In practice, planners should identify areas of eroding military advantage along with the operating concepts and capabilities to maintain or restore those advantages.⁹⁴

As shown by the first light blue row in Table 5, the candidate force construct prioritises shaping and sizing the future RAF for a major NATO Article V response to a great power’s act of aggression, such as an invasion of one or more of the Baltic States. This should be the pacing scenario for assessing the RAF’s potential future capability and capacity requirements. As suggested by results of the Strategic Choices Exercise, concepts of operation (CONOPs) for this scenario could prioritise using the RAF as a rapid response force of choice to counter adversary A2/AD systems and provide support to friendly ground forces. The CONOPs could also require RAF planners to develop and assess alternative concepts and capabilities for generating combat mass and maintaining secure and reliable battle networks in contested operating environments.

High-end capabilities designed to suppress A2/AD threats would be applicable across a widening range of scenarios as advanced defences proliferate to other states and non-state actors. Such a force would also provide the RAF with the ability to act against less capable aggressors independently of NATO and provide the United Kingdom with significant influence within a coalition of powers.

Defence of the Homeland and Support to Strategic Deterrence

As previously framed, an FPC for the RAF should include homeland defence and other enduring commitments. Requirements for these missions would include sustaining air sovereignty, defending the homeland from air and missile attacks, and maritime surveillance operations. These operations would require forces and capabilities that are additive to requirements for major conflict pacing scenarios.

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94 For more on understanding trends in military competitions, see Stillion and Clark, *What it Takes to Win*.

The most significant additional capability requirements for homeland defence would likely be air and missile defences to counter attacks and capabilities needed to deter and, if necessary, defeat threats against distant UK territories. This would include ISR capabilities to provide sensor coverage of possible ballistic missile or cruise missile azimuths of attack during a major conflict with a great power. Other additive requirements should include forces needed to augment the United Kingdom's air sovereignty posture and support for at-sea strategic deterrence operations during a crisis or conflict in Europe or another region. These additive forces would help deter opportunistic attacks on the homeland by a great power or another opportunistic aggressor.

Stress Against “Lesser” Scenarios and Missions

While preparing for an Article V conflict and homeland defence may be the principle requirements that shape the size and shape of the RAF, planners should then stress test the forces required for those scenarios against other possible scenarios. Some of these scenarios, such as conflict against a regional aggressor, might require some specialised capabilities beyond that which are required for the RAF's core missions, whereas others may be lesser cases covered by the baseline force. As shown by the white rows in Table 5, these other scenarios should include support to NATO or other coalition interventions against grey zone aggression and a level of support for multiple small, and possibly highly dispersed, counter-terror operations.

Summary

The RAF should consider developing a new force planning construct to guide the size and shape of its future requirements as it confronts the renewed challenge of great power competition. A force planning construct that is informed by new operational concepts and emerging technologies would provide a framework to help RAF planners govern trade-offs across force structure and programmes for future capabilities. It would facilitate the prioritisation of missions and help the RAF identify how it can remain a tier one air force that is the force of choice for defeating anti-access and area denial challenges, and hence maintain the United Kingdom's influence and position as the partner of choice.

Conclusion

Thirty years after the Cold War, the United Kingdom is assessing requirements for a future Joint Force that meets the nation's security needs in an increasingly complex and dangerous environment. Russia's aggression in Eastern Europe and China's expansionist actions in the East and South China Seas have heralded the return of great power competition. Both have been emboldened by their development of A2/AD complexes that provide overwatch for their actions. The proliferation of modern air defence systems, guided missiles, and other weapons to rogue states and non-state actors such as Hezbollah also pose a threat to the UK's security interests. Moreover, the threat from transnational terrorist groups will be enduring. Unlike in the 1990s and early 2000s, the United Kingdom must now prepare to confront these challenges and other threats in parallel, rather than sequentially. This will require a sustained level of defence spending that will support modest growth in the size of the Joint Force and modernisation programmes that will keep it a ready, lethal force in the future.

Three decades of cuts to the RAF's forces and modernisation programmes have strained its ability to meet its current operational commitments and prepare for future challenges. These cuts occurred as Russia and China focused their military investments on developing A2/AD complexes to delay or prevent Western air forces from projecting airpower into areas they have targeted. In order to restore its competitive advantage and remain a top tier air force, the RAF should develop operating concepts and requirements for a future force structure to counter the A2/AD complexes of great power aggressors.

The candidate force planning construct and other recommendations in this report address the most dangerous and most likely challenges the RAF may face in the coming years. They are the beginning of a framework that is intended to help inform follow-on analyses of the RAF's force capacity and resource requirements to prepare for future security challenges. As the RAF refines its force planning priorities, it should consider performing the following supplemental analyses.

- Develop and assess new operational concepts. The RAF should assess a range of new operating concepts for a future NATO Article V response, defence of the homeland, and support to the United Kingdom's at-sea strategic deterrent. In this era of renewed great power competition, the RAF should not assume that it will be able to continue to project power as it has in the past against lesser militaries. New operating concepts as well as improved capabilities and increased force capacity will be needed for the RAF to remain a top-tier air force.
- Develop and assess a force planning construct for the future. A force planning construct should provide a means to assess the RAF's future force capacity needs as well as its capability requirements. Both should be informed by analyses of what may be required to support air operations for a range of pacing scenarios. These analyses should be resource *informed*, not resource constrained, to allow senior policymakers to better understand the risks associated with different resourcing levels.
- Stress alternative RAF force structures against other potential scenarios. It is impossible to predict the exact timing and type of scenarios the RAF will confront in the coming years. As such, the RAF should also assess the ability of its future force to support long-term peacetime competitions with great powers, deter aggression in the grey zone, and counter terrorism at low to moderate risk.

LIST OF ACRONYMS

A2/AD	anti-access/area denial
AEWC2	airborne early warning and command and control
AWACS	Airborne Warning and Control System
BMC3	battle management command, control, and communications
BVRAAM	beyond visual range air-to-air missile
C3	command, control and communications
CBRN	Chemical, Biological, Radiological, and Nuclear
CCD	camouflage, concealment, and deception
CFO	Chief Financial Officer
CONOPS	concepts of operation
CSBA	Center for Strategic and Budgetary Assessments
DIA	Defense Intelligence Agency
DIT DSO	Department for International Trade Defence and Security Organisation
EMS	electromagnetic spectrum
FCAS	Future Combat Air System
FPC	force planning construct
FYDP	Future Years Defence Program
GDP	gross domestic product
GIUK gap	Greenland, Iceland, and the United Kingdom gap
G-RAMM	guided rockets, artillery, mortars, and munitions
IADS	integrated air defence systems
IED	improvised explosive devices
IISS	International Institute for Strategic Studies
ISIS	Islamic State in Iraq and Syria
ISR	intelligence, surveillance, and reconnaissance
ISTAR	intelligence, surveillance, target acquisition, and reconnaissance
JSTARS	Joint Surveillance Target Attack Radar System
LACM	land-attack cruise missile
LVC	Life, Virtual and Constructive
MoD	Ministry of Defence
NATO	North Atlantic Treaty Organisation
ONI	Office of Naval Intelligence
OPTEMPO	operational tempo
OSD	Office of the Secretary of Defense
OUSD	Office of the Under Secretary of Defense
PED	processing, exploitation, and dissemination
PGM	precision-guided munition
PLA	People's Liberation Army

RAF	Royal Air Force
SIPRI	Stockholm International Peace Research Institute
STOVL	short take-off and vertical landing
TESSOC	Terrorism, Espionage, Subversion, Sabotage, and Organised Crime
UAV	unmanned aerial vehicle
UCAV	unmanned combat air vehicle
VHJTF	Very High Readiness Joint Task Force



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