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MINISTRY OF DEFENCE

# Joint Concept Note 3/12 **Future Air and Space Operating Concept**



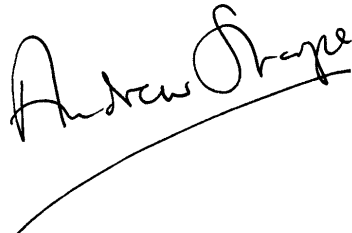
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## **JOINT CONCEPT NOTE 3/12**

### **FUTURE AIR AND SPACE OPERATING CONCEPT**

Joint Concept Note 3/12 (JCN 3/12), dated September 2012,  
is promulgated  
as directed by the Joint Force Commander and Chiefs of Staff

A handwritten signature in black ink, reading "Andrew Drape". The signature is written in a cursive style and is positioned above a long, thin horizontal line that extends to the left and then curves downwards.

Director Concepts and Doctrine

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## Foreword

Recent events suggest air and space power will have an increasingly vital role to play across security and defence: not only in the essential and enduring task of defending the United Kingdom, but also in providing the most rapid and responsive means of projecting power and influence wherever it is required, to secure our national interests in an increasingly globalized world. The UK could, then, be facing a 'strategic moment': a 'confluence of different trends that are full of possibilities, but also difficult to interpret and liable to evolve rapidly, a time when major choices with long term consequences cannot be avoided'. This is triggering profound changes in our Defence strategy, as the UK's Armed Forces adapt to the shifting landscape of national security. This trend is set to continue and deepen out to 2035; consequently, with the Royal Air Force as Defence's strategic lead in the air and space environments, I believe it is apt that the Future Air and Space Operating Concept (FASOC) should be refreshed at this time.

Significant economic, social, environmental and technological challenges lie ahead, and we must recognise that hard choices will have to be made and difficult balances struck. These include the relative priority we give to each of the air and space roles; the correct balance between manned and remotely piloted air systems; the optimum time to embrace new technologies, such as those involved in cyber capability and directed energy weapons; the balance between quality and quantity; the right level of investment in a more resilient national space capability; and the agility to take advantage of radical, but effective alternate solutions, both bespoke and/or commercial.

We also need to consider where our comparative advantage lies in the very unpredictable and evolving future of air and space dependence; and where, and in what, we should invest. One of FASOC's most important conclusions is that military success is likely to depend on the training and ability of our people to think radically, as much as on the kit that they use. I am determined that this is a key area that must be secured.

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It is in both the interests of Defence and national security to be able to project and employ air power (nay, military force) effectively to achieve the desired national effects, and in so doing, minimise the need for and/or size of a military deployment. Consequently, I welcome FASOC as a way of informing national decision making about the development of air and space power over the next two decades and beyond. It is essential reading and I commend it to you.

A handwritten signature in black ink that reads "Stephen Dalton". The signature is written in a cursive style and is underlined with a single horizontal stroke.

Chief of the Air Staff

5 September 2012

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## **Preface**

### **Purpose**

The Future Air and Space Operating Concept (FASOC) provides broad guidance for air and space concept, force and capability development out to 2035. This date is based on the anticipated timing and remit of the defence review cycle.

### **Structure**

FASOC is divided into three chapters.

- Chapter 1 considers the future strategic context for UK air and space operations, including the guidance provided by national policy and the impact of emerging strategic trends.
- Chapter 2 analyses the changing character of the air and space operating environments, and then describes the likely implications.
- Chapter 3 assesses the future delivery of air and space power through its four fundamental roles, enabled by an adaptive system of air command and control.

### **Linkages**

The Joint Operating Concept will define the overall context for future British military operations. In conjunction with the Future Maritime Operating Concept and the Future Land Operating Concept, FASOC is intended to support its development by providing the deductions and implications specific to the air and space environments. This version of FASOC replaces the previous iteration, FASOC 2009, and is consistent with the principles defined in AP3000: *British Air and Space Power Doctrine*.

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## **Key point summary**

1. FASOC sets the framework for air and space concept, force and capability development out to 2035.
2. Within this timeframe, the fundamental purpose of our air forces will be to protect the UK (and its overseas dependencies) from attack. They will also provide the most rapid and responsive military means of projecting national power globally.
3. The shift from campaigning to contingency will put an emphasis on two of air and space power's unique attributes. These are:
  - its ability to contribute to the rapid provision of understanding; and
  - to hold potential adversaries at continuous risk. This can be either directly from the UK, or through the global deployment and employment of air and space capabilities.
4. The agreed force structure for 2020 will endure for much of the FASOC timeframe. Consequently, enhancing capability will largely depend on improving employing air power employment through:
  - more effectively integrating capabilities;
  - better concepts of use and processes of command and control; and
  - spirally developing existing platforms, involving incremental upgrades of sensors, weapons and networks.
5. Beyond 2030, the scheduled retirement of fourth generation-plus capability offers the opportunity to develop a combat air system based on a mix of fifth generation manned, and sixth generation manned, remotely piloted or unmanned technologies. The research and development requirement means this will only be achieved if near-term investment is committed.
6. Command and control will be critical in creating momentum through tempo, rather than mass, in a smaller joint force.

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- a. Larger-scale, complex or multinational operations will continue to be delivered through component command, with NATO structures and doctrine as the default.
  - b. Small-scale, UK-only operations may be conducted with a flatter, more integrated command and control structure, employing embedded environmental staffs rather than standalone components.
  - c. The air element of standing, national command structures must be agile enough to capitalise on air and space power's unique attributes of reach and responsiveness.
7. The US' strategic pivot towards Asia-Pacific means the UK, as one of the more capable European military powers, may have to act as a framework nation for operations in and around Europe. Accordingly, there needs to be an appropriate emphasis on foundation enabling capabilities. These include command and control, intelligence, surveillance and reconnaissance, and strategic mobility.
8. The UK air component is deficient in combat mass and financial constraints will make it difficult to address this shortfall. Increased reliance on partnerships and alliances will be necessary. The persistence of remotely piloted air systems may also provide a compensating force multiplier effect in more permissive environments. Additionally, a greater emphasis on weapons and weapon numbers (including stand-off weaponry deployable from large or less-sophisticated carrying platforms) could supplement kinetic attack capabilities.
9. Electronic and navigation warfare and cyber operations will continue to grow in importance as enabling capabilities, defensive necessities and for offensive use. The air component must engage with the development of military cyber capability through Joint Forces Command to ensure that its defensive and offensive requirements can be addressed.
10. Space will become increasingly integral to both national security and military operations, but its delivery is disjointed across Defence. The RAF is the *de facto* environmental lead, but roles and responsibilities must be coordinated with Joint Forces Command for ownership of the space control



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mission and the delivery of space-enabled command, control, computing, communications, intelligence, surveillance and reconnaissance functions.

11. The first requirement is to develop an enhanced national space situational awareness capability. This demands:

- the creation and management of a cadre of military space expertise; and
- the development of existing capability into a proper hub that can be used to fuse military, civil and commercial space surveillance capabilities.

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## FUTURE AIR AND SPACE OPERATING CONCEPT

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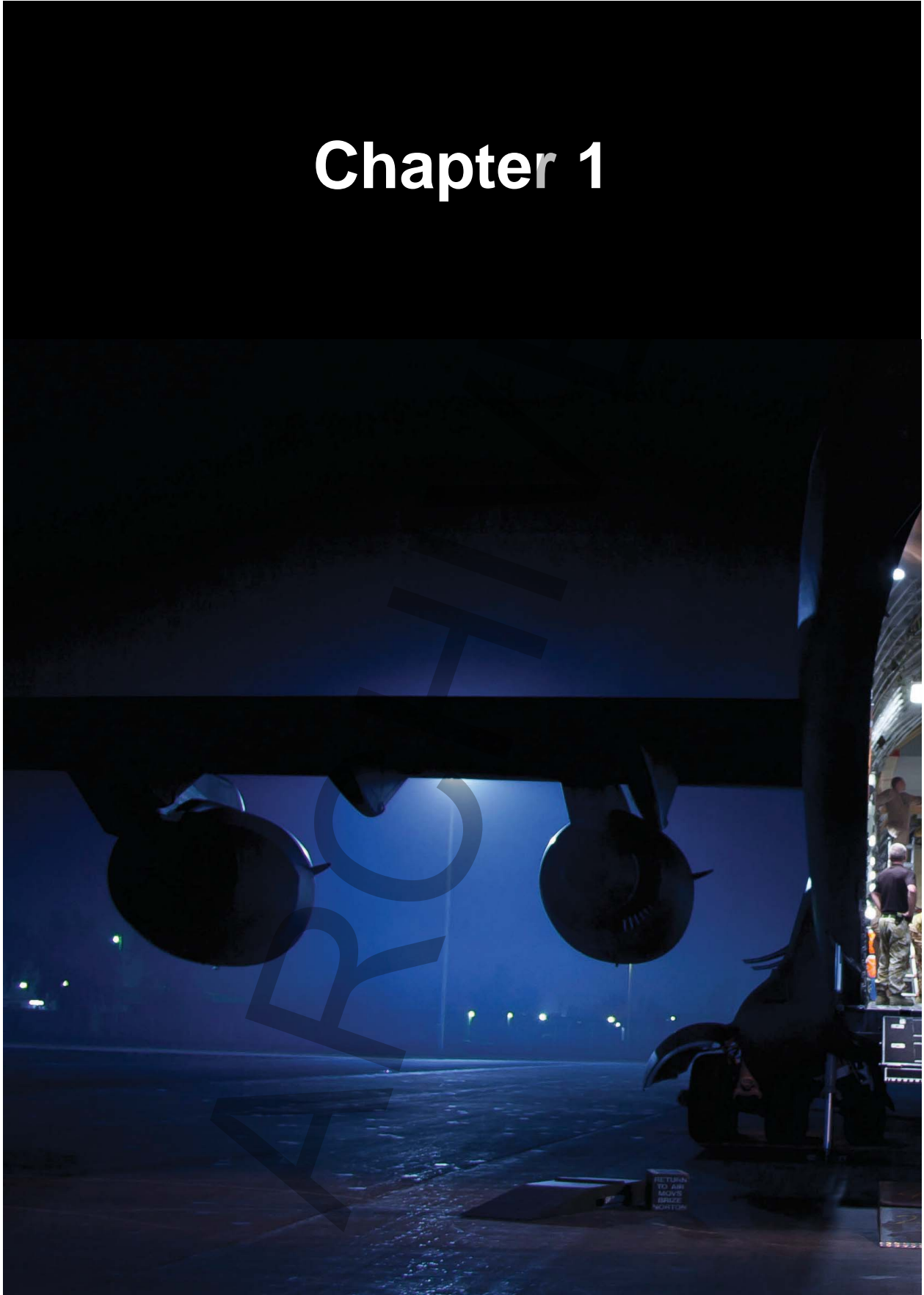
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# Chapter 1



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*The Royal Air Force is not just important to our nation's security, it is completely and utterly essential.*

Rt Hon David Cameron MP, Prime Minister



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The future air and space strategic context

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## Chapter 1 – The future air and space strategic context

101. This chapter considers the future strategic context for air and space power. It begins by describing how air and space operations can support UK policy by contributing to the security posture mandated by the National Security Strategy.<sup>1</sup> It then analyses the implications of emerging strategic trends for the air and space component, including:

- the shifting distribution of global power;
- the austere economic environment;
- environmental concerns;
- the closing technology gap between ‘the West and the rest’; and
- the UK’s increasing dependence on partnerships and alliances.

102. Three aspects of terminology may require clarification.

a. *Remotely piloted air system* is used to describe a system directly controlled by a human operator. *Unmanned air system* is used for autonomous or highly automated systems.

b. As a generic operating concept, FASOC does not consider specific capabilities in type or numbers. Where the text refers to capability in generations, Typhoon may be regarded as an example of *fourth generation-plus* capability and F35B Lightning as *fifth generation*. *Sixth generation* is a combat system likely to possess enhanced attributes of reach, persistence, network-enabled capability, and situational awareness. It may well be unmanned and should be able to survive in high-risk threat environments that may include directed energy weapon, electronic and cyber attack.

c. *Space* and *cyberspace* are interdependent, but distinctly different. Although space, like cyber, is an enabling domain, it also represents an operating environment in its own right.<sup>2</sup>

<sup>1</sup> *A Strong Britain in an Age of Uncertainty: The National Security Strategy* (London: HMSO), October 2010.

<sup>2</sup> Cyberspace is described as ‘an interdependent network of information technology infrastructures’ (JDN 3/12).



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## Air and space power as an instrument of policy

### National Security

103. The National Security Strategy identifies two core security objectives.
- a. To ensure a secure and resilient UK by protecting our people, economy, infrastructure, territory and ways of life from all major risks that can affect us directly.
  - b. To shape a stable world by:
    - acting to reduce the likelihood of risks affecting the UK, or our global interests overseas; and
    - applying our instruments of power and influence to shape the global environment and tackle risks at source.<sup>3</sup>

### Security principles

104. These objectives will be met through a flexible security posture, an 'Adaptable Britain', embodying five key principles.<sup>4</sup>
- a. **Engaging upstream**, identifying and managing threats before they materialise in the UK. This will be achieved through 'soft power' influence activity and conflict prevention based on diplomacy, deterrence and aid. Air power's contribution will include conventional deterrence, based on the demonstrable ability to hold an adversary at continuous risk of immediate and sustained attack from secure bases.
  - b. **Maintaining a broad spectrum of military capabilities** with sufficient flexibility to adjust to changing future requirements. This implies a balance of capabilities across all four core air and space roles<sup>5</sup> including the ability to conduct independent, UK-only operations. This will limit the extent to which capabilities can be

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<sup>3</sup> *Op.Cit.*, National Security Strategy.

<sup>4</sup> *Ibid.*

<sup>5</sup> Control of the air, intelligence and situational awareness, air mobility and lift and attack.

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traded between roles, or role-specialisation adopted within the force development process.

- c. Strengthening mutual dependence through a much greater emphasis on **alliances and partnerships**. This implies a reinvigorated approach towards interoperability, engagement and the manning of influence posts in alliance and coalition headquarters.
- d. Establishing a more coherent, **integrated approach** to security across government. This means the air component must enhance its capability to work with other government departments and agencies and will have implications for training and education. This must include the legal constraints involved in operating with non-military actors.
- e. Ensuring capabilities have in-built **flexibility** to adjust to changing future requirements. This favours an emphasis on systems, not platforms, the adoption of genuinely multi-role or role-configurable capabilities and the introduction of a spiral and incremental development philosophy.

### **Military tasks**

105. The Strategic Defence and Security Review<sup>6</sup> translates the military contribution to achieving an Adaptable Britain into seven tasks:

- defending the UK and its overseas territories;
- providing strategic intelligence;
- nuclear deterrence;
- supporting civil emergency organisations in times of crisis;
- defending UK interests through strategic power projection and expeditionary interventions;
- providing a defence contribution to UK influence; and
- providing security for stabilisation.

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<sup>6</sup> *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review* (London: HMSO), October 2010.

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106. All seven military tasks have a significant dependency on space, but this is implied rather than specified.<sup>7</sup> Similarly, the delivery of space across defence is not well defined, although the RAF is the acknowledged *de facto* environmental lead. The forthcoming National Space Security Policy is expected to clarify roles and responsibilities.<sup>8</sup>

### The purpose of UK air forces

107. The UK's air and space component must therefore contribute to all seven military tasks with an appropriate emphasis on the five principles outlined within the National Security Strategy. However, the particular attributes of air and space power mean that the most significant contribution to national security will be through the two tasks that play directly to the twin national security objectives, thus assuring the Government's political freedom of manoeuvre. Accordingly, the fundamental purpose of UK air forces may be considered as:

- **protecting** the UK and its dependent overseas territories from attack, particularly (but not exclusively) from the air; and
- providing the most rapid and responsive means of **projecting** power to secure the UK's national interests globally, either directly from the UK homeland, or as part of an expeditionary operation.<sup>9</sup>

### Core air and space functions

108. Adaptable Britain demands *simultaneity*, so the air component's duty to meet its standing commitments, notably 'protecting', must continue to be delivered while projecting power and influence on a contingent basis. Each of the two core functions – protect and project – has associated implications. These are described below.

109. Protecting the UK (and its dependent overseas territories) demands an integrated air defence system (including air platforms, sensors, infrastructure, personnel, and command and control structures) capable of countering conventional<sup>10</sup> and less conventional air and space threats. Out to 2035, the

<sup>7</sup> Examples have been assessed within the Multinational Experiment 7 process: 'Space': see *Space: Dependencies, Vulnerabilities and Threats* (DCDC) 2012.

<sup>8</sup> However, the National Space Security Policy, scheduled for release in July 2012, has been delayed.

<sup>9</sup> Unless a maritime asset is in the vicinity of the area of interest.

<sup>10</sup> For example, unauthorised or unidentified military or civilian aircraft entering UK airspace.

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latter may include: emerging technologies such as electro-magnetic pulse weapons and micro- and nano-unmanned air systems; and threats to the UK's access to space through cyber or electronic attack. The proliferation of long-range ballistic missiles (armed with either conventional, or potentially, chemical, biological, radiation or nuclear warheads) will also pose an increasing threat.

110. Projecting power more rapidly and responsively than other levers of force generates three sets of requirements.

a. **Long-range capabilities able to deliver influence and effect directly from the UK, free of the constraints of physical barriers and national boundaries.** This should include access to space assets capable of global employment.<sup>11</sup>

b. **The ability to deploy air power overseas.** This may involve operations from naval platforms (including carrier strike) or from land bases. The latter offer many advantages over sea-based air power in terms of enduring presence and ease of sortie-generation, but they may be austere. This implies a requirement for expeditionary support, sustainment, force protection and command and control capabilities.

c. **Power projection may also be provided by burden-sharing with allies and partners to secure shared global interests.** In particular, the Strategic Defence and Security Review assumes that enduring stabilisation operations will only be conducted within coalition.

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<sup>11</sup> Current space-based ISR is provided by access to allies' capabilities.

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## **Deductions and implications – UK policy**

### **Principles for the employment of air and space forces**

111. UK air forces must contribute to the Adaptable Britain Security posture. This will involve an emphasis on:

- upstream engagement;
- maintaining a broad spectrum of military capabilities;
- alliances and partnerships;
- an integrated approach to crisis management; and
- flexibility to meet changing requirements. (Para 104)

112. UK air forces must contribute to all seven military tasks mandated by the Strategic Defence and Security Review. (Para 105)

113. The military tasks depend on space capabilities but this is implied, not specified. Roles and responsibilities for space security must be determined. (Para 106)

### **The purpose of UK air forces**

114. Securing the airspace of the UK (and its dependent overseas territories) will remain core to the air component's purpose throughout the concept timeframe. (Paras 107 – 110)

115. It will also be necessary to project air and space power globally. This may involve operating directly from the UK; from overseas bases or maritime assets; or as an integral part of a deployed, joint expeditionary force. (Paras 107 – 110)

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## **The impact of emerging strategic trends on air and space power**

### **The shifting balance of global power**

116. The balance of global power may be shifting away from the US and western Europe towards emerging economies, particularly China and the other BRICS states.<sup>12</sup> The differential impact of the global recession of 2008 has highlighted this dynamic with Asia-Pacific, South America and Africa recovering more quickly and strongly than Europe and North America. However, in absolute terms, the US is likely to remain the most important military power for most of the concept timeframe,<sup>13</sup> although it may be overtaken by China before 2035 as the world's biggest economy and defence spender.<sup>14</sup> The UK is also likely to retain a defence budget among the world's top ten. But relatively, the West's power and influence may decline markedly. The diffusion of power is already evident in the:

- transition from the G7 to the G20 as the global economic forum, and the aspirations of Germany, India, Brazil, Japan and Nigeria for seats on the United Nations Security Council;
- increasing influence of groups such as the African Union and Arab League; and
- attempts by states such as Iran to establish themselves as regional hegemons.

Meanwhile, the rise of China provides an alternative to liberal democracy as a politico-economic model for developing states, especially as the wars in Iraq and Afghanistan have eroded western prestige and influence.

### **Economic constraints**

117. Although the UK aspires to continue to play an active and influential role in world affairs, debt reduction has been identified as the national priority. This means defence spending will continue to fall in real terms until 2015,

<sup>12</sup> Brazil, Russia, India, China and South Africa.

<sup>13</sup> Despite its reducing defence budget and China's significant expansion in military spending, in 2015 the USA is predicted to spend US\$611.13B on defence as opposed to China's \$222.23 and the UK's \$51.89.

<sup>14</sup> '2016: When China overtakes the US', *The Guardian*, 27 April 2011.

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with little likelihood of significant increases subsequently.<sup>15</sup> This has two major implications for the UK's air forces:

- a. There will be continuing pressure to reduce operating and manpower costs. This will demand new approaches to capability procurement and support as well as a continuing drive to reduce the numbers of regular, uniformed personnel. The result will be further emphasis on the whole force concept, making best use of all available manpower, including civil servants, contractors and reservists.
- b. The scope for any major capability procurements beyond the current equipment programme will be very limited. The force structure to 2020 has been broadly agreed, while aerospace's dependence on advanced technology means it is prone to lengthy development programmes and defence inflation.<sup>16</sup> This makes it unlikely that many more new capabilities will enter service before 2030, when fourth generation combat air capability is scheduled for retirement. The resulting capability gap may be filled by migration towards a flexible combat system based on a mix of capabilities, including advanced unmanned air systems. However, early investment in research and development will be required if sixth generation capability is to be delivered in the required timescale.

118. Improving capability in the interim will therefore largely depend on establishing better ways of using existing equipment rather than introducing new platforms. Such measures may include:

- enhancing processes of command and control;
- better training through distributed simulation;
- introducing more capable enabling networks to improve the integration of capabilities across the joint force; and
- adopting spiral development, including incremental (and ideally modular) upgrades to weapons, sensors, software and systems.

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<sup>15</sup> UK defence spending will fall by 12.24% between 2008 and 2015. Although the defence budget will be increased by 1.8%, this represents a cut in real terms taking inflation into account: *UK Defence and Security: A New Approach?* House of Commons Library Research Paper 11/10, 21 January 2011, p.27. This mirrors an equivalent cut in the US of 13.04% over the same period; in contrast, China's defence budget will increase by 219.69%, India's by 79.52% and Russia's by 67.49%: *Janes Defence Weekly*, Vol. 44, Issue 44, 2 November 2011, p.29.

<sup>16</sup> Despite the rigorous reforms to Defence procurement currently being implemented.

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## Maintaining a military edge?

119. The shifting balance of power means that reduced research, development and procurement budgets relative to potential adversaries will progressively erode the technology gap between 'the West and the rest' from 2020 onwards.<sup>17</sup> While there is little likelihood of direct conflict between the UK and states such as Russia and China, rapid diffusion of military technologies developed by these nations can be expected to state and non-state actors elsewhere. Consequently, the UK may not be able to assume either a quantitative or qualitative advantage over many potential adversaries. Likely opponents may also be more agile as adopters of new technology. They may be less fettered by the need for transparency and the resulting bureaucracy inherent in procurement processes in western democracies. They may also be free of many of the legal and ethical concerns that constrain novel weapon concepts in the West. Some potential adversaries are likely to gain access to nuclear, biological, radiation or chemical weapons within the concept timeframe. They may also have few inhibitions about their employment.

120. While the proliferation of advanced technology is a cause for concern, its optimal use demands a supporting culture and philosophy that is not instinctive. The acquisition of sophisticated equipment does not necessarily imply the immediate ability to operate it in service effectively.<sup>18</sup> Military capability not only depends on the **physical component** (the means to fight) but also on the **moral component** (getting people to fight) and the **conceptual component**<sup>19</sup> (the way that force is used in terms of doctrine, strategy and tactics). This is shown in Figure 1.1.

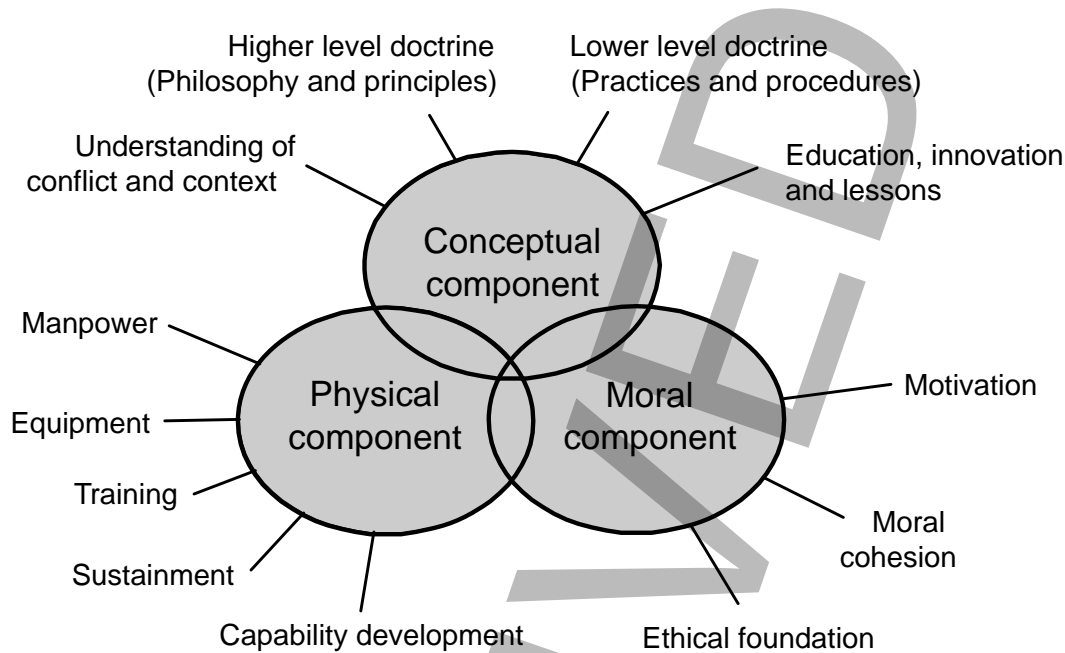
<sup>17</sup> Future breakthroughs in areas such as micro-processing, software engineering, data storage, semi-conductors and nanotechnology may be innovated in Europe or North America, but are more likely to be exploited in Asia-Pacific. Joint Defence Publication (JDP) 0-01: *British Defence Doctrine* Fourth Edition (MOD), page 4-4. [www.mod.uk/dcdc](http://www.mod.uk/dcdc).

<sup>18</sup> For example, Middle Eastern states that have bought sophisticated fighter aircraft have not always been able to support and operate them in service without a high level of external support.

<sup>19</sup> For example, in 1940 the *Wehrmacht* had fewer tanks of less capability than the French Army, but was able to win by finding a more effective way to employ them as part of the integrated *blitzkrieg* air-land campaign.



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**Figure 1.1 – The components of fighting power**

121. Ultimately, both the moral and conceptual components depend on the quality of people. Given the resource constraints on the physical component, these are the only areas where we can realistically aspire to create a military edge beyond 2020. However, changes in terms and conditions of service, reduced force structure and redundancies have arguably eroded this potential advantage. Assuring it in the future will depend on sufficient priority being given to an effective recruitment, retention and retirement policy within a very taut budget. Also, a continuing commitment to world-class military education, not just specialist training, will be necessary for the relatively few personnel identified as key to the delivery of the conceptual component of fighting power.

### **The environment**

122. Environmental awareness continues to grow in western societies and aviation is a particular target for lobby groups. Rising fuel prices, insecurity of supply and government targets on energy consumption may all constrain future air activities. Technology is beginning to provide alternative fuel and energy solutions. These should be explored as a means of assuring the military fuel supply, both to increase resilience to strategic shocks and third

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party actions, and to reduce the carbon footprint of air operations within a robust system of operational energy management. However, there must be no compromise on performance, which is critical in the military environment.

123. Although fuel is only a small component of overall operating costs, rising prices and sensitivity to noise pollution will increase the pressure to substitute simulation for flying. This may also improve the quality of training by integrating force elements more closely,<sup>20</sup> while reducing spares usage and the buy-to-deploy ratio necessary to sustain air platform fleets. The balance to be struck will evolve as the quality of simulation improves, and the downsides must be acknowledged. These include:

- a reduction in the benefits of live flying, both for collective military training and for other government departments, such as the UK Borders Agency;
- the enduring requirement to train other elements of the total operating system, including engineers, aircraft handlers and air traffic controllers;
- the need to surge from synthetic to live flying for operations will have to be built into support contracts; and
- manning structures (including the potentially negative impact on retention) will have to be reassessed.

However, many inhibitors to change are now largely cultural rather than practical. It is likely that the ratio of live-to-simulated flying could be rebalanced markedly if the necessary investment in technology is committed in the near-term.

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<sup>20</sup> Cross-component simulation will also need to deliver air-derived products and capabilities to the other components, particularly as the British Army will be largely UK-based from 2020 onwards and the scope for live exercising may be limited.

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## **Partnerships and alliances**

124. The relative decline in western military power means that partnerships and alliances will be necessary to generate and sustain combat mass. They may also provide the balance of capabilities that will become more difficult for any one nation to provide on its own. For example, UK policy assumes that enduring stabilisation operations will only be conducted in coalition. This means the posture and willingness of allies to commit must be carefully considered during the planning and estimate process.

125. The close alliance with the US will continue to be vital, particularly for intelligence and access to space capabilities. These underpin the UK's critical national infrastructure and act as key enablers for military operations across all environments. To assure this relationship, we will have to retain our ability to operate alongside our US counterparts, providing useful and ideally self-supporting capabilities to combined operations. However, UK/US interoperability may have to be confined to areas such as command and control and planning if the costs of deep, tactical-level integration of systems and equipment escalate beyond the bounds of affordability. Analysis is therefore required to assess which integrators are critical, and where a more basic level of de-confliction and awareness is sufficient to assure interoperability.

126. While the US will remain the UK's military partner of choice, it is running short of the will and capability to intervene where its own national interests are not directly at stake. As the US' focus shifts towards East Asia and the Pacific Rim, its allies will be expected to take more responsibility for security issues in their own areas of primary strategic concern, notably Europe and Africa. In these areas, the US may 'facilitate success, not lead it'.<sup>21</sup> Consequently, the UK must identify other security partnerships that complement its key military relationship with the US.

127. NATO remains the West's primary security institution. Recent operations in Afghanistan and Libya have demonstrated that it can act as the core of an expanding network of wider partnerships well outside its traditional areas of interest. Therefore, NATO 'should provide the principal framework for the majority of UK operations and we should commit to it wholeheartedly'.<sup>22</sup> European NATO allies cannot replicate the full range of

<sup>21</sup> Speech by President Obama, 19 November 2011.

<sup>22</sup> D/CDS/5/2/1 *How We Fight*, dated 27 Jan 12.

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capabilities provided by the US, particularly in terms of the command, control, computing, communications and intelligence functions necessary for all military operations. However, the UK and France are two of the states most capable of acting as framework nations in the absence of a US lead, although substantial support would be required from other partners – both to provide niche capabilities, and generate a force of viable size.

128. The increasingly globalized nature of security is likely to lead to the creation of *ad hoc* partnerships in communities of shared interests on a case-by-case basis. For example, anti-piracy operations off the Horn of Africa involve a European Union mission, but employ a command and control structure based on a NATO framework and involve China and India as contributors. Similar coalitions are likely to proliferate in the future, involving unfamiliar and sometimes uncomfortable partners or even, as in Libya in 2011, non-state actors. Air power may play a significant role in such operations. It can provide enabling capabilities for less-sophisticated military partners without, in some circumstances, the necessity of a major manpower commitment on the ground. However, this will require a broadening of the scope of current doctrine and new processes of air-land integration.

129. Every opportunity must therefore be taken (within the binding resource constraints) to promote interoperability and engage with as broad a range of potential air and space partners as possible. These will include the most technologically sophisticated (US and NATO air forces) through to less familiar, less capable, but potentially likely collaborators. This should include live and virtual exercises where possible, but increased emphasis must also be placed on more affordable and cost-effective initiatives. Examples may include:

- cooperation on concept and doctrine development, including experimentation and war-gaming; and
- a revitalised exchange and attaché programme as part of an integrated, cross-government approach to upstream engagement.

130. We should seek to gain and maintain more influence within NATO, both in terms of air headquarters manning and, particularly, in shaping the development of Alliance doctrine and concepts as the basis for interoperability. The primacy of NATO (*vice* national) doctrine may then be acknowledged without reservation and taught and employed with confidence.

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## Deductions and implications – Strategic trends

131. Continuing economic pressure will drive initiatives to cut operating costs. These are likely to include innovative approaches to platform procurement and support, and an emphasis on a *whole force concept* to make the most effective use of manpower. (Para 119)

132. Few new platforms are likely to enter service before 2035. Capability enhancement will therefore depend on the incremental introduction of better processes of command and control and concepts of use, modular upgrades, and cyber and electronic warfare capabilities. (Para 120)

133. The West's comparative advantage in advanced military technology will diminish progressively from 2020 onwards. Our military edge will therefore depend as much on the way we employ capability as on the quality of our equipment. This demands institutionalised air power education and a rigorous approach to identifying personnel key to the conceptual component of fighting power. They will also need to be supported by a career structure that prepares, employs and rewards them appropriately. (Paras 121-123)

134. Alternative fuels should be explored as a means of increasing resilience of supply and reducing the carbon footprint of air activities as one aspect of a robust system of operational energy management. (Para 124)

135. Near-term investment in simulation could enable a rebalancing of live and simulated flying. This would improve individual and collective training while reducing operating costs, spares use, and buy-to-deploy ratios. (Para 125)

136. The US is likely to remain the UK's most important military ally. We need to analyse and identify which integrators are key to affordable UK/US interoperability in the future. (Paras 117-118). NATO provides the best extant framework for military partnership. The Franco-British military axis should be used as an opportunity to strengthen NATO by driving transformation from within. (Paras 126-129)

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The future air and space strategic context

137. Air and space power may be used to support unfamiliar partners in *ad hoc* coalitions. Conceptual development is necessary to understand how effective integration can be achieved with less-sophisticated or even irregular forces. (Para 130)

138. NATO structures, architecture and doctrine should be adopted as the default for UK operations. This will facilitate participation in Alliance operations, and also act as the basis for interoperability with less familiar partners. (Para 131)

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## Chapter 2



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*Information is critical, 'time is a weapon', and we need to use air power's ability to exploit the fourth dimension to take advantage of fleeting opportunities as they arise.*

Air Chief Marshal Sir Stephen Dalton , Chief of the Air Staff





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## Chapter 2 – The character of the future air and space operating environments

201. Our future military operations will vary in duration and intensity, but are likely to require force projection. They will be typified by:

- issues of problematic target discrimination;
- the increased influence of space and cyber operations; and
- the requirement to integrate more closely with a plethora of joint, inter-agency and multinational actors and organisations.

202. Unless a compelling narrative is offered, such operations may be regarded by the British public as discretionary, so there will be limited tolerance of casualties and correspondingly high expectations for force protection. Even in operations considered to be non-discretionary, civilian – and even enemy – casualties will cause concern. Media scrutiny will be intense, and domestic public support cannot be assumed – it will have to be earned. The future operating environment is likely to be **congested, cluttered, contested, connected and constrained**.<sup>1</sup> This chapter considers the particular implications of each of these characteristics.

### Congested

#### The battlespace

203. Populations will increasingly be concentrated in urban areas, predominantly located in coastal belts. These densely congested regions are likely locations for future operations, as they will be subject to acute sources of stress and instability, especially as irregular combatants seek to fight ‘amongst the people’.<sup>2</sup> The proliferation of remotely piloted air systems (including joint and even civil platforms) operating above these confined areas will intensify the congestion of airspace. The requirement for intelligence, surveillance and reconnaissance (ISR) and the volume of data collected will be large, and operations risk being swamped by the sheer number of potential targets. Therefore, a well-developed command, control, computing, communications

<sup>1</sup> DCDC Strategic Trends Programme, *Global Strategic Trends – Out to 2040* (London: MoD), pp. 88-90.

<sup>2</sup> A term coined by General Sir Rupert Smith in *The Utility of Force*, (London: Penguin) 2006.

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and intelligence capability, including effective battlespace management, will be essential.

### **Cross-domain integration**

204. Operations in such congested areas will be conducted along and across the environmental seams. For the last decade, the joint focus has been on air-land integration, but in the future, deeper synchronisation of activities and effects will be necessary across all components. For example, air-maritime integration will be more important in the littoral, or where adversaries use anti-access tactics to seek to deter interventions. However, space represents an environment in its own right, while cyber has become a unique operating domain. The conceptual focus in the future must therefore be on genuine, cross-domain integration, rather than bi-environmental cooperation.

### **Space**

205. Space itself is becoming increasingly congested, as more actors develop launch capabilities and wider use is made of satellites for military and commercial purposes. Over 50 nations already operate in space. We are seeing increasing competition for the most sought after locations in low-earth and geosynchronous orbits. The increasing amount of space debris also presents a growing hazard to the UK's assured access to space.<sup>3</sup>

### **Cluttered**

206. Congested environments will create clutter, providing many opportunities for concealment and making targets difficult to acquire and track. This will put a premium on the ability to gather and share information rapidly. There will be few neutral spaces, with hospitals, schools and places of worship forming part of the operational landscape. Precision, time-critical decision making and attack capabilities will be essential. This requires platforms that are able to combine the find and attack functions to compress the sensor-to-shooter cycle. However, persistence will also be essential where target acquisition is so difficult that kill-chain times cannot be reduced. Effective

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<sup>3</sup> The US tracks over 22,000 objects bigger than 10cm in low-earth orbit. There is a real risk that further satellite collisions may render some orbital regimes untenable. *Flight International*, 12-18 June 2012.

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sensor coverage, available when and where it is required, and exploited through analysis and data retrieval tools, is likely to offer the best way to cut through the clutter. Self-protection measures, including electronic warfare and low observable technology, will be important where platforms are required to loiter in hostile airspace.

## **Contested**

### **A spectrum of threats**

207. Adversaries are likely to contest any and all environments, using a mixture of orthodox and unconventional techniques. Hezbollah, for example, used sophisticated anti-ship and anti-tank missiles as well as asymmetric tactics in the war in Lebanon in 2006. Platform and personnel protection must therefore evolve to meet both high- and low-end threats, and we must be fully prepared to fight to deliver all of the four air power roles.

### **Contested access**

208. The technological advantage enjoyed by western nations will diminish as advanced anti-access weapons proliferate. This will make force projection and sustainment more difficult and threatens traditional conceptions of expeditionary operations. Diesel submarines and offensive cyber capabilities are two examples, but a particular concern is the development of advanced, long-range precision weapons that can be networked and integrated with sophisticated over-the-horizon surveillance systems.<sup>4</sup> These capabilities are likely to be exported, allowing potential adversaries to threaten our freedom of air and naval manoeuvre at distance. At closer range, intra-theatre missiles, integrated air defences, fast attack boat swarms and mines may all be used to attempt to deny access, especially in chokepoints such as the Straits of Hormuz. This means that control of the air will be essential to enable freedom of air, surface and sub-surface manoeuvre. Contested access also has the potential to undermine the credibility of conventional deterrence if some actors believe they can disregard international norms free of the fear of intervention or reprisal. Consequently, air power's ability to hold adversaries at continuous

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<sup>4</sup> These include anti-ship ballistic missiles with maneuverable warheads such as the Chinese DF-21D, cruise missiles such as the DH-10, and improved mobile ballistic and air defence missiles such as the Russian S-300/400/500 series and Chinese HQ-9 variants.

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risk without (in some circumstances) the necessity of a commitment on the ground will be important in providing policy options and political choices.<sup>5</sup>

## **Security**

209. Operations will also be contested in other, less expected ways. As reachback is increasingly employed to limit the footprint in theatre, it may be more productive for an adversary to attack command and control networks and other supporting enablers, including the home base, rather than seeking to destroy air vehicles or force elements in theatre. Many aspects of the contested future operating environment will therefore challenge existing ethical and legal norms of warfare. A renewed emphasis on security, in all its forms, is essential. The threat will be less objective, but more pervasive and multi-dimensional than it was in the Cold War, particularly in an era of shared information and social networking. We will require physical and operational security measures to protect increasingly scarce and consequently, more valuable assets. This includes our equipment, personnel and information.

## **Connected**

### **The competition for information**

210. The spectrum of conflict will blur, broaden and become increasingly connected within physical and virtual networks. Ready access to a global information grid, including social networking, has '*broken a state's ability to control and monopolise the flow of information*'.<sup>6</sup> This will ease the leakage of conflicts across national boundaries and provide adversaries with virtual sanctuaries, where they may gain moral encouragement and access to knowledge and resources.<sup>7</sup> In an increasingly complex and competitive information environment, air and space operations must be part of the battle for influence. Otherwise, our adversaries will negate the comparative advantage offered by air power by seeking to exploit any activities that can be portrayed as disproportionate or indiscriminate. Accordingly, strategic communication must be central to every air campaign plan. Every air

<sup>5</sup> Note the US continues to give priority to renewing its long range strike capability within a shrinking budget.

<sup>6</sup> US Army TRADOC Operational Environment 2009-25:  
<http://www.idsi.com/FOE/file.axd?file=2010%2F8%2FOperational+Environment+2009-2025.pdf>

<sup>7</sup> For example, through disseminating tactics from a conflict in one region to another, or by providing on-line instruction manuals for the manufacture of weapons and explosives.

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commander must have an agile, responsive and authoritative capability to inform and rebut.

### **Network dependencies**

211. Air capabilities will become increasingly dependent on networks (many hosted by space bearers) for the rapid and effective transmission of data and information. This offers a potentially battle-winning edge, but also represents a vulnerability that must be defended, as the networks may be subject to both intentional and inadvertent disruption.<sup>8</sup> A better understanding of dependencies, which are often transparent to the user, must be achieved, so that malicious or environmental degradation can be mitigated. We must also understand how to affect our adversaries' networks, including knowledge of the second order effects that may result from successful disruption operations. The UK is investing in cyber capabilities on a cross-government basis,<sup>9</sup> but Defence must do more. While Joint Forces Command is taking the lead for military cyber operations, the air component must understand its own dependencies, requirements and vulnerabilities. This will then enable us to determine ownership and the division of responsibilities; not least for coordinating the offensive cyber operations that will play an important part in future air campaigns. This is not just a cyber issue. Electronic and navigation warfare, as well as signals intelligence, will also play an important defensive and offensive role in an increasingly networked operating environment.

## **Constrained**

### **Legal challenges**

212. Western societal norms will continue to impose legal and ethical constraints on the conduct of operations, particularly where interventions may be regarded by the public as discretionary, rather than essential, to the national interest. Their aversion to casualties will depend on a perception of the stakes involved, but is likely to encompass enemy forces and civilians as well as friendly forces, shaped by pervasive media scrutiny: this will act as a constraint in its own right. Discrimination between combatants and non-

<sup>8</sup> On 4 December 2011, Iran reportedly captured a US RQ-170 surveillance unmanned air system by jamming the data-link and 'spoofing' the GPS signal, so it landed intact at an Iranian airfield rather than its operating base in Afghanistan. *Jane's Defence Weekly*, 14 December 2011, p.6.

<sup>9</sup> £650 million was made available in 2010 for UK cyber security.

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combatants may be problematic, and the legal and moral obligation to minimise collateral damage will increasingly require proportionality and precision. While legally permissible, non-precision weaponry (or the inadvertent failure of precision weapons to avoid all collateral damage) may generate adverse perceptions that undermine the perceived legitimacy of air operations. The law can be used to an advantage if engagement is proactive. The military activities we would wish to conduct are legal; but the issues involved must be examined, so we can articulate what is being done, and why. This means we must also establish a comprehensive audit trail, and ensure that it is properly managed and archived.

### **Ethical constraints**

213. Although we now associate air power with the delivery of precise effects, the misperception that it is a disproportionately violent, detached and indiscriminate form of military force will be encouraged by adversaries who fear its reach, precision and ubiquity. Legal challenges may be raised against novel technologies such as electro-magnetic pulse weapons, unmanned air systems and non-lethal weapons. Ethical concerns may result in policy constraints on their use, while the application of domestic law and international human rights legislation may impose further, unanticipated restrictions. The need for transparency and compliance with the legal, moral and ethical principles that uphold the legitimacy of the employment of force will guide and limit the scope of future air and space operations. However, it is highly unlikely that similar sensitivities will restrict (or be reciprocated by) many of our potential adversaries.

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## Deductions and implications – Future air and space environments

### Congested

214. Developing effective, adaptive systems of command, control, computing, communications and intelligence will be critical to military success in congested operating environments. (Para 202)

215. *Air-land* or *air-maritime* integration will be insufficient. In the future, the conceptual focus must be on *cross-domain integration*, to properly synchronise air and space activities with maritime, land and cyber operations. (Para 203)

216. The increasingly congested nature of space demands improved space situational awareness so that the hazards and threats can be properly understood. (Para 204)

### Cluttered

217. Air and space systems will be essential to provide the persistent and pervasive data collection and attack capabilities necessary in cluttered operational environments. This will involve:

- Compressing the 'sense-to-effect' cycle, including the continuing development of genuinely multi-role platforms able to combine the find and strike functions.
- Emphasising survivability, to assure persistence where the kill-chain cannot be shortened. (Para 205)



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The character of the future air and space operating environments

### **Contested**

218. We must configure platform and personnel protection against both high- and low-end threats. (Para 206) Our use of air power's as a tool of conventional deterrence is likely to increase as traditional expeditionary operations become more risky. This underscores a continuing requirement for power-projection capabilities, including access to space assets, long-range strike and air refuelling, stand-off weaponry and remote basing. (Para 207)

219. Renewing our emphasis on the discipline of security is necessary to safeguard scarce assets in an increasingly contested environment of proliferating threats. This must include physical and personnel security. (Para 208)

### **Connected**

220. A properly resourced and proactive strategic communication capability will be essential to the future delivery of air power. (Para 209)

221. Offensive and defensive cyber operations will be key to air and space operations. Although Joint Forces Command will act as the focal point, the air component must identify its own dependencies and vulnerabilities to assure coordination of the delivery of the required capability. (Para 210)

### **Constrained**

222. Legal support and advice will be an integral part of air and space operations, particularly during mission preparation and the targeting process. (Para 211)

223. We can expect legal challenges to emerging technologies. Conceptual development must keep pace with the legal and ethical debate if the potential of novel weapons is to be exploited. (Para 212)

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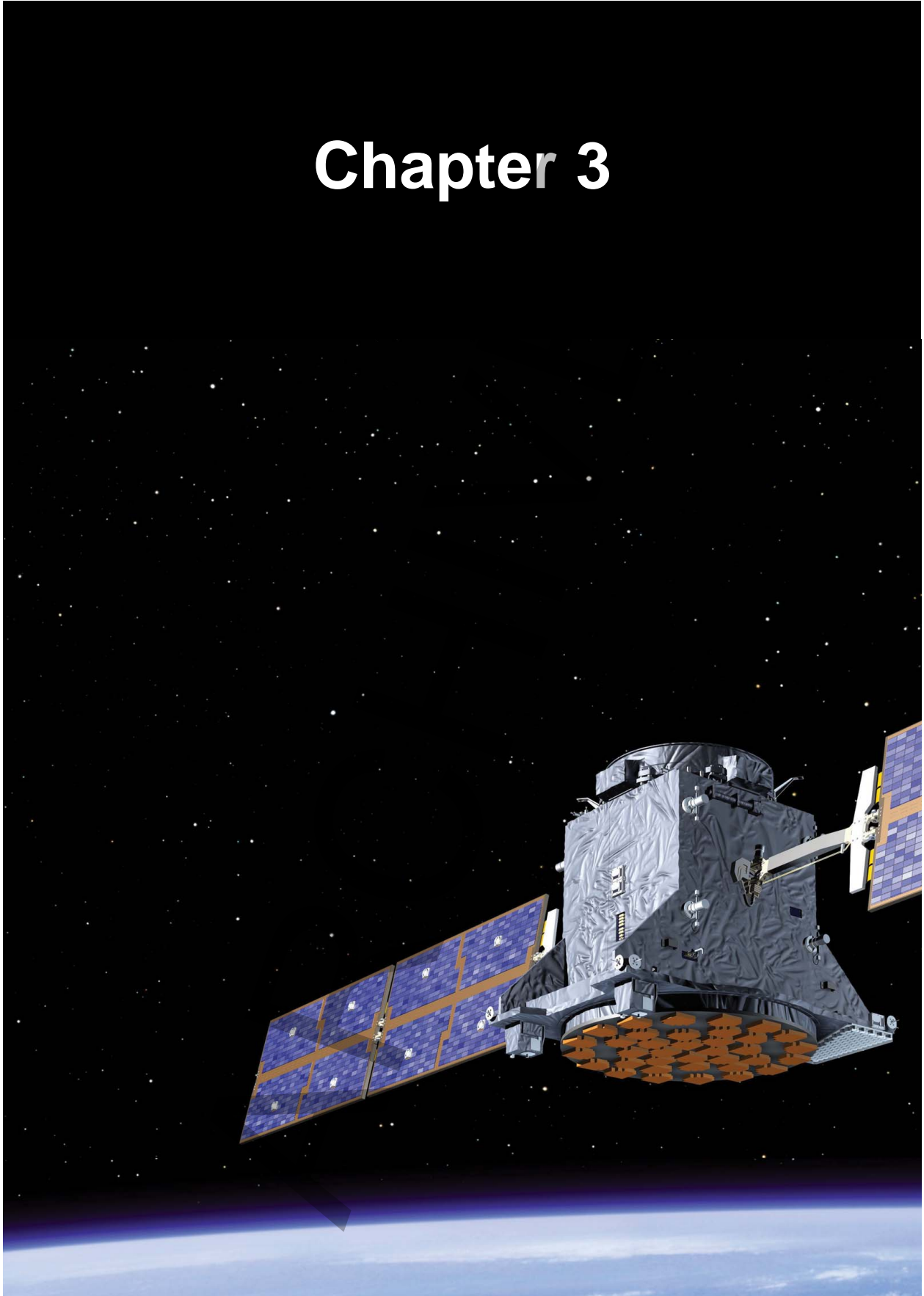
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# Chapter 3

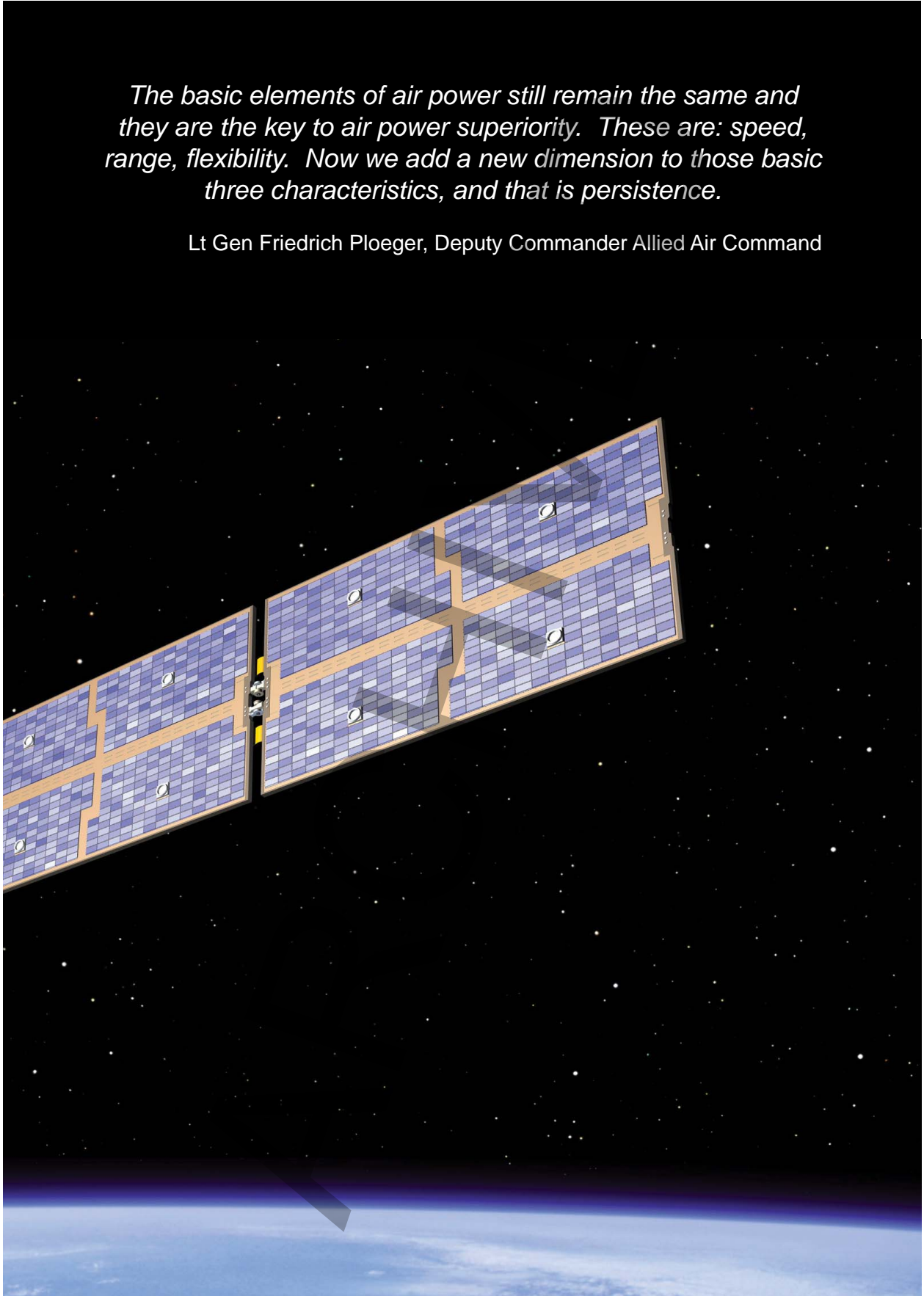


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*The basic elements of air power still remain the same and they are the key to air power superiority. These are: speed, range, flexibility. Now we add a new dimension to those basic three characteristics, and that is persistence.*

Lt Gen Friedrich Ploeger, Deputy Commander Allied Air Command



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The future delivery of air and space power

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The future delivery of air and space power

## **Chapter 3 – The future delivery of air and space power**

### **The evolution of the four fundamental air and space roles**

301. The concept of four fundamental air and space roles, enabled by specialist air command and control,<sup>1</sup> will retain its relevance as a framework for understanding and employing air power throughout the Future Air and Space Operating Concept (FASOC) timeframe. However, the delivery of the roles will change as concepts and doctrine, technology, and the character of the operating environment all evolve. Air power has traditionally been delivered by role-specific and often single-function platforms, but the trend towards genuinely multi-role capabilities means that air operations will increasingly be defined by the desired effects and the context of employment, not by the type of platform used. Consequently, this chapter is split into three sections to:

- consider the future development of the four air power roles;
- assess our requirement for a more adaptive system of air command and control; and
- address the balance and interdependence between roles.

### **Role 1 – Control of the air and space**

#### **Control of the air<sup>2</sup>**

302. Two facets of control of the air explain its enduring conceptual primacy.

- a. The RAF was originally created to assure the UK's security from aerial attack. Maintaining the integrity of the UK's airspace will remain one of its most fundamental duties.<sup>3</sup> The political and strategic consequences of success or failure to control the skies above a nation's homeland are always dramatic, with examples ranging from the Battle of Britain in 1940 to the Kosovo air campaign in 1999. The

<sup>1</sup> Control of the air and space, mobility and lift, intelligence and situational awareness, and attack. AP 3000 *British Air and Space Power Doctrine*, (4<sup>th</sup> Edition) (London: MOD), 2009.

<sup>2</sup> *The freedom, bound by time, to use an area of airspace for one's own purposes while, if necessary, denying its use to an opponent. Ibid.*

<sup>3</sup> This includes dependent overseas territories, such as the Falkland Islands.

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control of the air capabilities necessary to defend the UK (and its dependent overseas territories) must therefore be given appropriate priority, including considering a missile defence capability.

b. The expeditionary posture mandated by national policy means that we must also retain an ability to achieve a measure of control of the air (bounded by space and time) at distance from the UK. While we may attempt expeditionary military operations without control of the air, the risks are very high, because control of the air assures freedom of air as well as surface and sub-surface manoeuvre. It thus determines the ability of the joint commander to gain, and retain, the initiative.

303. While the nature of the requirement for control of the air is enduring, the character of the contest is changing. Although we have become accustomed to operating with control of the air since the Falklands War in 1982, this has never been absolute, despite the extent of recent western air dominance. Even in Afghanistan, operations have been constrained by surface fires. In the concept timeframe, air operations are likely to be challenged in three different ways.

a. **Asymmetric tactics.** Any aircraft without appropriate protection, or not employing effective tactics, may be threatened by simple, yet effective, weapons such as anti-aircraft artillery, small arms fire and man-portable air defence missiles. Additionally, specialist force protection will remain necessary to mitigate the risk of mortar and rocket fire<sup>4</sup> as well as the use of improvised explosive devices against forward operating bases, tactical landing zones and other vital ground key to air and space operations.

b. **The 'battle of the narratives'.** Our control of the air will also be challenged in the information domain. Adversaries will exploit the 24/7 news media to question the ethical and legal basis of air power, aiming to constrain our freedom to use it as we choose. Unless such narratives can be countered credibly and responsively, even opponents lacking conventional air, and air defence, capabilities may be able to compromise the effectiveness of air power.

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<sup>4</sup> Particularly if precision-guided indirect fire technology diffuses to potential adversaries.

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c. **Anti-access and area denial strategies.** Some states are aiming to deter traditional intervention operations by developing capabilities to contest access into theatres of operation, and deny the lodgement areas required by a joint force once it has deployed.<sup>5</sup> In the air environment, threats include the proliferation of modern surface-to-air missiles employed within properly integrated air defence systems (including electronic warfare and cyber attack capabilities) and potentially, the sophisticated, fifth-generation Russian and Chinese fighter aircraft that are likely to be available for export. Attacks on a deployed force by swarms of unmanned air systems and theatre ballistic or other surface-to-surface missiles are also conceivable. Finally, although they may not yet be operationally feasible, directed energy weapons used in a surface-to-air mode may offer a significant threat to our air operations towards the end of the concept timeframe. In particular 'low and slow' movers and remotely piloted systems, with their inherent dependence on data links, are likely to be vulnerable.

304. Achieving sufficient control of the air in the future threat environment will therefore demand a range of capabilities beyond any single Service. In particular, creating an effective system of deployed air defence will require a closely synchronised, cross-component effort to harness appropriate capabilities. These may include, for example, the Army's ground-based air defence units and the Royal Navy's Type 45 destroyers. Close integration and continuing joint education will therefore be necessary to ensure that control of the air is properly understood by all components as a prerequisite for joint operations, not a distraction from other environmental tasks.

305. While an advanced combat air capability will be necessary to contest control of the air, we must strike a balance. We should maintain a technological edge over the adversaries most likely to be faced in a UK-only or UK-led coalition. However, we will only undertake operations against adversaries possessing the most sophisticated anti-access threats in an alliance. Consequently more 'exquisite' capabilities may not be required. In such scenarios, a useful and ideally self-supporting contribution to complement our most important allies' capabilities will be sufficient.

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<sup>5</sup> The US's Joint Opposed Access Concept was approved 17 January 2012 based around the 'A2AD' (anti access and area denial) threat.



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306. Unmanned combat air vehicles are likely to form part of the future control of the air force-mix, as they may offer advantages in terms of endurance, range or manoeuvrability. However, the dynamic complexity of 'fighter-versus-fighter'-type missions does not favour remote control. We also need to resolve other technical, legal and ethical issues before highly automated or autonomous platforms can be deployed. Consequently, a wholly unmanned capability for the air-to-air role is unlikely to be achievable or desirable within the concept timeframe.<sup>6</sup> Instead, we should regard manned, remotely piloted and unmanned air systems as complementary capabilities for the air-to-air mission.

#### **Control of space<sup>7</sup>**

307. **The UK's dependency on space.** Awareness of our dependence on space-enabled capabilities is growing, reflected in the recent formation of a UK National Space Agency and the ongoing development of a National Space Security Policy. All nine elements of the UK's critical national infrastructure rely to a greater or lesser extent on space.<sup>8</sup> Similarly, 90% of our military capability is assessed to have a dependency on space, particularly for GPS-enabled precision navigation and timing functions.<sup>9</sup> This is especially true for expeditionary operations, which are unlikely to enjoy access to terrestrial infrastructure and so depend on space-based capabilities for communications, imagery and intelligence, and even accurate weather forecasting. Although control of the air and space is a fundamental air and space role, the RAF has yet to take full institutional ownership of the UK's space control mission. This must be addressed, in conjunction with Joint Forces Command, in the near-term, both to assure access to a key military enabler, and protect the UK's growing civil and commercial interests in space.

308. **Drivers of the UK space control mission.** Currently, space control in a UK context depends on cooperating with allies, access to commercial sources and exploiting specialist knowledge rather than on our own

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<sup>6</sup> *Ibid.*

<sup>7</sup> 'The conditions, bound by time, that enable effective space support of military operations' (AP3000 4<sup>th</sup> Edition).

<sup>8</sup> 'There are nine sectors which deliver essential services: energy, food, water, transport, telecommunications, government and public services, emergency services, health and finance. Within these sectors there are key elements that comprise the critical national infrastructure. These are the components or assets without which the essential services cannot be delivered. These components may be physical or electronic.' [www.cpni.gov.uk/About/whatIs.aspx](http://www.cpni.gov.uk/About/whatIs.aspx)

<sup>9</sup> 240 military applications for GPS have been identified. Only 40% of these have been specified with military standard, encrypted GPS.

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sovereign capabilities.<sup>10</sup> Three issues will drive the development of the UK's space control mission within the FASOC timeframe.

- a. **Our critical dependency on the US.** We rely on the US for access to space capabilities and products. It may be prudent to mitigate this dependency if the US' ability to support its allies becomes constrained by budgetary pressures, its own increasing requirements, the switch in focus away from areas of shared strategic interest, or commercial pressure to share what is perceived to be surplus capacity. Although our space requirements are currently met in full, access is often informal. For example, there is no established mechanism to request US space support for UK operations where the US is not involved, such as a UK non-combatant evacuation operation.
- b. **Congested space.** Emerging space-faring nations are seeking what they perceive to be equitable access to the space commons. They are increasingly contesting the established order in space by disputing treaties and customary agreements and competing for the best satellite orbits and most sought after geosynchronous locations.<sup>11</sup> De-confliction is a growing problem, as is the proliferation of debris in space. This is increasing the requirement for us to develop a more comprehensive national space situational awareness capability to understand the environment, the actors involved, and the nature of activities being conducted in space.
- c. **Adversary access.** The proliferation of military and commercial satellites means that all our future adversaries – state and non-state – can be expected to enjoy access to space capabilities. Space denial must therefore be considered as an integral part of campaign planning. Moreover, our own freedom of action in space is likely to be threatened by increasingly space-aware adversaries. At one end of the scale, this may simply involve GPS-jamming. At the other extreme, China has already demonstrated the will and capability to destroy satellites in space. There have also been open-press reports

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<sup>10</sup> The UK is the only G20 nation without any operational, government owned, satellites. Military SATCOM is delivered commercially, by the Paradigm PFI; the UK Government has also provided research and development funding for the TOPSAT and forthcoming NOVO-SAR technology demonstration programmes.

<sup>11</sup> Particularly (but not exclusively) the 1967 Outer Space Treaty.

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of soft-kill cyber attacks on data-links controlling civilian satellites.<sup>12</sup> However, our deployable headquarters (except the Joint Force Air Component Headquarters) are unlikely to possess organic space expertise. Also, space factors are largely disregarded in our current doctrine planning and estimate process.<sup>13</sup> This means there is a real danger that space may be ignored in the development of joint campaign objectives and courses of action.

309. **Space situational awareness.** We should therefore seek to provide a limited degree of redundancy and resilience to assure the UK's access to space. As a priority, we should expand and manage our small cadre of UK military space specialists more effectively. This would enable us to define our requirement for space capabilities, provide advice and expertise, and audit our dependencies and vulnerabilities. Enhancing our national space situational awareness is the first step towards assuring space control. Although an understanding of our adversary's space activities – especially warning of satellite pass-times – is significant within a narrowly military context, space situational awareness is also more broadly useful across government. Examples include:

- attribution of attack;
- treaty verification;
- deterrence; and
- spacecraft licensing and compliance.

The existing RAF Space Operations Coordination Centre provides rudimentary collision warning advice to commercial spacecraft operators on an unfunded, 'at-risk' basis, but there is growing demand across the UK space sector for access to an improved level of space awareness. This is necessary to prevent collisions, mitigate space weather effects and assist in anomaly resolution, including radio frequency interference.<sup>14</sup>

<sup>12</sup> In 2007, China destroyed a redundant Fenyung 1C satellite, creating a cloud of some 35,000 pieces of orbital debris, while the USA successfully intercepted one of its own satellites in 2008.

<sup>13</sup> While JDP 0-01 *British Defence Doctrine* recognises space as a discrete operating environment, there is no reference to it in JDP 5-00 *Campaign Planning*.

<sup>14</sup> *The Case for Space Situational Awareness*, UK Space Association Trade Paper 2010.

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310. The Space Operations Coordination Centre could act as the basis for a more effective hub if its role was expanded to lever all of the UK's existing military, civil and commercial space situational awareness capabilities. These include intelligence, sensors (including civil and commercial radio and optical telescopes) and tracking information, expertise and analytical tools. Fusing these inputs into a more comprehensive, recognised space picture would provide better understanding and advice to decision makers. It would also create a sovereign database outside UK/US protocols, and thus applicable within broader alliance contexts.

311. **Counter-space operations.** Defensive and offensive counter-space operations are sub-sets of the space control mission.

a. **Defensive counter-space operations.** Defensive counter-space measures will become increasingly important as highly capable military and commercial space-based intelligence, surveillance and reconnaissance (ISR) platforms proliferate. Otherwise, our ability to conduct operations unobserved by foreign powers and the international media will be constrained. This threatens our ability to apply surprise as a principle of war and reinforces the requirement for an effective satellite warning system, based on a robust space situational awareness capability. Additionally, the development of concealment and deception techniques against space-based intelligence collection would be prudent.

b. **Offensive counter-space operations.** Offensive counter-space measures are constrained by differing legal and policy perspectives. These include ambiguous definitions of where space begins, and differing interpretations of the 1967 Outer Space Treaty. UK policy directs that counter-space operations must only result in temporary and reversible effects to on-station space systems, although attacks on the ground segment and its associated control and data links are legal and permissible. However, we need to consider the second order effects of such actions carefully. For example, the destruction of satellite communication (SATCOM) dishes to isolate a leader from his population could lead to the loss of satellite control, the risk of collision and the creation of debris fields in key orbital regimes. This would generate disproportionate effects when set against the military necessity underpinning the initial attack. Legal and targeting

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competencies must therefore be developed in parallel with space-denial capabilities such as electronic and cyber attack. This would enable the second order effects of degrading terrestrial space infrastructure to be assessed, and the law of armed conflict (and rules of engagement) to be applied properly within a space-related context. Commanders must also be aware of the legal and policy perspectives of key allies (including caveats and national red cards) towards counter-space operations, so they can understand any residual impact of such operations on UK forces acting within coalition.

## **Deductions and implications – Control of the air and space**

### **Control of the air**

312. Control of the air will remain a priority task, both to defend the UK and to enable deployed operations. Traditional, specialised capabilities will be required, including air platforms, missiles and radar. However, we should also explore a mix of technologies, such as cyber capabilities, unmanned air systems and novel anti-air defences. (Para 302)

313. There will be a requirement for missile defence within the concept timeframe. This is most likely to be addressed through multinational collaboration, although we may need to enhance national early warning capability in parallel with a developing space situational awareness capability. (Para 302)

314. Irregular adversaries will contest control of the air by using non-specialist weaponry to attack deployed bases. They will also seek to exploit the information domain. This implies we must continue to invest in specialist force protection and strategic communications. Such capabilities should be seen as an integral part of the control of the air mission. (Para 303)

315. Although air and space control will remain the primary responsibility of the air component, synchronised, cross-domain integration of effects will be required to lever capabilities residing in all of the Service environments to meet the range of potential emerging threats. (Para 304)

316. The viability of unmanned combat air systems in the air-to-air role is not certain within the concept timeframe. They are likely to form part, but not all, of control of the air capability by 2035. (Para 306)

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### **Control of space**

317. The demonstrable importance of space and its increasingly contested nature reinforce the requirement for institutional ownership of the space control mission to be agreed across UK Defence. (Para 307)

318. We must fully incorporate space into joint doctrine so that it is given appropriate weight in the campaign planning process. (Para 308)

319. The need to audit and mitigate UK space dependencies implies that we must establish a cadre of expertise. We should also develop an enhanced military space situational awareness hub as the precursor to any potential acquisition of indigenous space capabilities. (Paras 309-310)

320. We need to renew our focus on counter-space operations to deny our adversaries access to space and assure our own freedom of action. (Para 311)

### **Role 2 – Air mobility and lift<sup>15</sup>**

321. Air mobility enables the global, regional and local deployment of military and civilian personnel, and materiel. While air mobility is limited in payload compared to surface lift, it provides the quickest way to deploy and sustain light forces. In some circumstances, it is the only option to provide influence in the timescale required; often, and uniquely, directly to the point of need. Like control of the air, air mobility and lift is a fundamental enabler of surface manoeuvre, particularly in high-threat surface environments or where terrain is difficult or impassable. The need to project power and influence through expeditionary operations, coupled with the increasingly globalised nature of security crises, means that the demand for air lift will continue over the next two decades. This has been addressed by the recapitalisation of the fixed- and rotary-winged air transport fleets.<sup>16</sup> Although we are still required to sustain a brigade-sized stabilisation operation, future interventions may not follow the same pattern as recent, enduring, manpower-intensive counter-insurgencies. Instead, the emphasis may switch to expeditionary deployment

<sup>15</sup> *Air mobility and lift* is a fundamental air power role. AP3000, *British Air and Space Power Doctrine*. This should not be confused with land forces' definitions of air mobility, manoeuvre and assault.

<sup>16</sup> Through the introduction of C17, A400M Atlas, the Voyager air refuelling project, an increased Chinook fleet and upgraded Pumas.

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and tactical air lift, rather than enduring sustainment. Mobility also provides wider influence. It can be used to engage with our partners and assist other government departments' work. This includes promoting economic development and governance as part of an integrated approach to crisis resolution.

322. Ostensibly, we will perform air mobility and lift in the future much as it is at present. We will use air transport and air refuelling to project power and influence rapidly and responsively, employing a mix of fixed- and rotary-wing aircraft capable of both strategic and tactical effects. Those aircraft requiring access to contested battlespaces will need self-protection, including advanced counter-measures. However, air mobility aircraft may use their networked capabilities to help integrate the future combat air system. Additionally, roll-on, roll-off weapons modules and sensor packs are available for transport aircraft that could help restore combat mass in certain scenarios.<sup>17</sup>

323. Manning the air mobility force may pose a risk, as the civilian airline and helicopter sectors are predicted to expand in the medium-term despite the current economic downturn. Unmanned air systems have the capability to perform many lift roles, but legal issues, airspace regulation and cultural aversion are likely to limit early adoption for missions transporting personnel. The military will probably wait for a lead from the civil sector, and this is unlikely within the concept timeframe. Optionally manned platforms, such as hybrid air vehicles, may offer a compromise at an affordable price, but the currently endorsed equipment programme provides little headroom for such capabilities.<sup>18</sup>

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<sup>17</sup> For example, the US Marine Corps employs the Harvest HAWK system on its KC-130J transports.

<sup>18</sup> The US Army deployed two hybrid air vehicles to Afghanistan in 2012 at a reported unit cost of \$6M each.

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### **Deductions and implications – Air mobility and lift**

324. In contrast to increasing reachback and remote basing possibilities in other air power roles, our air transport assets will require in-theatre operating bases to deliver effect and influence directly to the point of need. This demands specialist force protection and trained personnel capable of activating, manning and defending deployed operating bases. (Para 319)

325. Weapon and ISR modules ease the integration of new weapons and could help restore combat mass in more benign scenarios. They could provide transport aircraft with multi-role capabilities as part of a future combat air system. (Para 320)

326. Despite their technical feasibility, unmanned air systems are unlikely to play a significant part in passenger-carrying air mobility operations within the concept timeframe. (Para 321)

### **Role 3 – Intelligence and situational awareness**

327. Surveillance and reconnaissance from the air and space provide intelligence and contribute to shared situational awareness. The unique vantage point allows sensors an almost unimpeded view 'over the hill' and across the electromagnetic domain. This helps to integrate the joint force at the operational level, while making a vital contribution to the national military task to generate strategic intelligence. The post-Afghanistan shift in strategic posture is likely to put an increasing premium on the responsiveness of air and, particularly, space assets in developing an understanding of unanticipated contingencies rapidly, and on a global basis.

#### **The intelligence cycle**

328. It is difficult to appreciate nuance and complexity from the air and space, as the human and social context cannot be mapped as readily as physical capabilities or terrain. Consequently, the transition from awareness to genuine understanding demands the fusion of information drawn from multiple sources, many of which cannot be derived from air and space



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capabilities.<sup>19</sup> We need to match our investment in sensors by developing our ability to direct, analyse, process and disseminate the increasing volume of data we will collect. We must adopt new processes to reduce the burden on analysts and allow adversary intent to be predicted more quickly, including automating the correlation of products and introducing multi-intelligence fusion and visualisation techniques. We have not yet fully recognised the extent to which the demand for intelligence will grow. Operating more remotely piloted air systems across all three services will require a fundamental reappraisal of policy and doctrine to ensure cross-component coherence.

### **Space-based intelligence, surveillance and reconnaissance**

329. Intelligence and situational awareness is becoming increasingly reliant on space. This trend is set to continue, particularly where terrestrial access is denied to air-breathing ISR platforms by the proliferation of more capable anti-access threats. The provision of US space-derived ISR to the UK is well assured, but we must acknowledge the dependency and some mitigation would be prudent. Commercial ISR products are increasingly available and could be used to meet any shortfall, but assured access to products of the right quality, at the time required, cannot be guaranteed.

330. Affordable options are emerging that would allow us to develop a limited, sovereign space-based ISR capability. Miniaturisation means that a single satellite can now host multiple payloads. This offers the potential for collaboration and cost-sharing at a number of levels: multinational; civil-military dual-use; or inter-agency, including service-level agreements with other government departments. The UK is also the global market leader in small satellite technology. The growing ubiquity and reduced cost of these systems make them increasingly attractive as a means of generating affordable capability quickly.<sup>20</sup> Not only are the space vehicles far cheaper than conventional satellites, but their small size means the cost of entry to space can be reduced markedly. For example, air-launching will be feasible as an alternative to traditional, expensive rocket-launching; particularly with the emergence of reusable suborbital platforms, such as the Virgin Galactic Spaceship and Skylon space plane. This would allow an operationally

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<sup>19</sup> Sources will include coalition partners and the provision of communications, signals, imagery, human and even meteorological intelligence, alongside a new approach to defence engagement on a routine basis.

<sup>20</sup> Small satellites in the pico to nano classes are currently costed at between £100,000 to £5M.

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responsive space programme to be developed, where existing space capability could be augmented or replaced within operationally useful timescales. For example, a small satellite could be air-launched into a highly-elliptic orbit to cover a particular area for a particular operation, if existing space coverage was considered to be inadequate.<sup>21</sup>

### **Network vulnerabilities**

331. Unmanned and other novel technologies are also proliferating. These include systems operating close to the boundary of space, potentially offering reasonably persistent ISR capabilities at reduced cost in comparison with space-based systems.<sup>22</sup> However, these systems, like space-based platforms, will be dependent on the electromagnetic domain for their control links and the transmission of products. This increases their vulnerability to cyber and electronic attack, reinforcing the requirement for passive defensive counter-measures and electronic hardening to be built into the ground segment and data-links of air and space ISR systems.

### **Deductions and implications – Intelligence and situational awareness**

332. The UK's shift in strategic posture will increase the requirement for responsive ISR configured for rapid understanding. (Para 325)

333. Developing collection technologies risk swamping analysts with a large volume of data. We should look again at our analysis techniques, processes and doctrine. (Para 326)

334. Our dependence on space-derived ISR indicates that it would be prudent to broaden our base of cooperation and consider developing a limited space capability. (Para 328)

335. Space-based and terrestrial ISR capabilities depend on networked command and data transmission links. These are vulnerable to disruption without suitable defensive counter-measures. (Para 329)

<sup>21</sup> Because there is no available satellite coverage, or where demand from data-hungry combat-ISR platforms threatens to outstrip supply.

<sup>22</sup> For example, the US is experimenting with helium balloons to provide a persistent, near-space capability.

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## **Role 4 – Attack**

336. While control of the air is the *sine qua non* for all joint operations, our ability to hold an adversary at constant risk from secure bases on sovereign territory lies at the heart of air power's value as a tool of deterrence. In contrast to sea-based air power, land-based air power can be held at extended readiness almost indefinitely, at multiple locations and across a much greater range of mission sets. This provides responsiveness through speed and range, not just presence. To assure this fundamental capability, we need to develop a combat system able to threaten continuously what an adversary values most. The critical attributes will be:

- the political will to employ force;
- reach;
- our ability to penetrate increasingly sophisticated defences;
- weapon payload, in terms of adequate precision and appropriate weight of effect; and
- an effective, end-to-end targeting process.

337. The speed, reach and responsiveness of air power offers a graduated range of credible threats, from diplomatic warnings and military signalling at one end of the spectrum, to employing precise and proportionate physical force at the other. In the future, the range of options is unlikely to change, but the way that the attack role is conducted will evolve. This will reflect developing technology, legal and ethical issues, and emerging threats, such that the role may eventually be regarded more broadly as air-delivered influence rather than attack *per se*.

### **A systems approach**

338. Our current attack capability is based on fourth generation manned platforms. As advanced threats proliferate, the small number of aircraft available means that even the lowest attrition rates may render a campaign unsustainable. Fifth generation, low observable capabilities will offer advantages as a force multiplier where a persistent presence is necessary in hostile airspace. However, low observable capability is difficult to develop and emerging technologies may erode its effectiveness over the FASOC timeframe. Consequently, we should depend less on the capability of

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individual platforms and shift towards a network-enabled systems approach based on a mix of technologies. This may include any, or all, of:

- offensive cyber attack;
- stand-off, stealthy and high-speed munitions;
- an increasing proportion of remotely piloted and unmanned air systems;
- directed energy weapons, if operationally feasible within the concept timeframe; and
- electronic warfare and attack.

### **Directed energy capabilities**

339. Such a combat system has the potential to revolutionise air power's use in the attack role, offering low collateral options and the vastly increased responsiveness offered by greater persistence. However, the usefulness of novel technologies is limited by constraints which will have to be resolved before they can be fully exploited. For example, directed energy weapons<sup>23</sup> potentially offer transformational capabilities across a broad spectrum of effects.<sup>24</sup> They can be tuned to disrupt electronic devices rather than destroy them, although this is likely to require a persistent attack using pulses of power. While air platforms currently carry a finite load of conventional ordnance (bombs and missiles), the effects delivered by directed energy weapons may be repeated simply by waiting for capacitors to be charged by on-board generators between engagements. Long-endurance unmanned air systems armed with directed energy weapons therefore potentially offer a persistent control of the air capability against integrated air defence systems, especially when coupled to offensive cyber operations. The combination of capabilities could disable air defences without the necessity for traditional, high-risk, defence suppression missions, although the directed energy weapon would still have to be brought into range by an air platform.<sup>25</sup>

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<sup>23</sup> Directed energy weapons may use either laser or radio frequency technologies. For radio frequency weapons, a distinction is often drawn between electronic-counter measures ('front-end' attack where the signal is delivered into the sensor through the antennae) and directed energy weapons ('rear-end' attack to exploit unintentional or unconventional vulnerabilities).

<sup>24</sup> These may include counter-materiel, counter-personnel and counter-system effects.

<sup>25</sup> Directed energy weapons are most relevant for suppressing non-networked systems that may not be accessible to traditional cyber vectors.

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340. Directed energy weapons, however, also have significant disadvantages. Measuring the effectiveness of attacks and the persistence of effects is problematic. Providing an energy source of the required size is also technically very difficult. Even radio frequency weapons need high power density and a very efficient antenna. The early deployment of practical, airborne, directed energy capabilities is therefore unlikely.

### **Weapons and stockpiles**

341. For force-on-force engagements, kinetic attack will continue to dominate with increasing precision and proportionality, although we will have to employ it with great discretion, particularly in stabilisation operations. Mass and capability may be restored by a renewed focus on weapons rather than the carrying platforms. Smart, stealthy, high speed, agile or stand off munitions will not be cheap in absolute terms, but can be developed more quickly and procured in greater numbers than densely complex combat air platforms. But we will need to assess in detail the most effective weapon mix to trade off capabilities. There is also an urgent need to reduce the costs and risks associated with weapon integration, including obsolescence and failure rates. Carriage life will be a particular issue, as there will be a heavy bias towards ISR vice attack in some scenarios, especially as the endurance of air platforms is also increasing progressively.

342. Developing modular, weapon-bus type concepts would mitigate some of these risks. Simple platforms could be used to carry large numbers of advanced weapons without the integration costs associated with more sophisticated combat air platforms. If carried in internal modules, the munitions would also exist in a benign environment that would extend weapon life. However, all air campaigns are unsustainable without access to adequate weapon stocks. Addressing this problem may involve revisiting our industrial strategy, the associated manufacturing production model and the 'just-in-time' re-supply philosophy. A greater emphasis on interoperability and commonality, rather than acquiring very limited numbers of highly bespoke weapons, could also add resilience, as we could seek access to allies' stockpiles when necessary.

343. Many precision weapons depend on GPS-guidance. It is highly likely that our potential adversaries will employ jamming techniques in the future to deny GPS cueing, navigation and guidance in the kill-chain. Consequently, we must continue to develop navigation warfare techniques and explore other

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capabilities to counter GPS-denial in the weapon delivery phase of the attack process. These may include scene- or terrain-matching techniques, or redundancy provided by multi-mode weapons able to use the best signal from any one of the several satellite-based navigation systems coming on line.

### **Targeting**

344. Finally, we must optimise the attack targeting process so that space, ISR, electronic warfare, cyber operations, kinetic attack and strategic communications form a continuum. Merely attempting to modify a largely kinetic targeting process to accommodate the whole spectrum of effects is unlikely to be successful. Command and control will also be critical, as intelligence gain and loss calculations for a mix of kinetic, non-kinetic and cyber operations are unlikely to be delegated from strategic to component command level.<sup>26</sup>

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<sup>26</sup> DCDC, *How We Fight: The Role of Military Power in Achieving National Objectives*, 2012.

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## **Deductions and implications – Attack**

345. The deterrent affect offered by a credible, long-range, precision attack capability is one of the UK's air forces' most significant attributes. We must assure this as a priority. This requires a mix of technologies to provide a credible capability in the future threat environment. (Paras 334-335)

346. Novel technologies offer the potential to transform the attack mission if synthesised into a coherent combat air system. This may include offensive cyber operations, electronic attack and the increasing employment of smart munitions and unmanned air systems. However, we will have to resolve many constraints before these technologies can be fully exploited. (Para 336)

347. The early deployment of a practical, airborne directed energy capability is unlikely, because of the energy-source requirement. Other novel capabilities, such as offensive cyber operations, are likely to make a more effective contribution within the concept timeframe. (Paras 337-338)

348. Near-term analysis is necessary to optimise the weapon mix. This will ensure ease of integration; meet emerging demands; and assure its usefulness over protracted periods of operation, through adequate carriage life and the ability for rapid replenishment. (Para 339)

349. Deploying appropriate and effective weapons, and assuming access to adequate weapon stocks are critical to sustaining a credible kinetic attack capability. (Para 340)

350. We should develop our tactics and equipment to militate against an over-dependence on GPS for weapons cueing and attack. (Para 341)

351. A full-spectrum targeting process is necessary. This should be nested in legal permissions and national level command and control structures to exploit the potential of emerging kinetic and non-kinetic attack technologies. (Para 342)

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### **Adaptive air command and control**

352. Responsive and effective air command (or more properly, command, control, computing, communications and intelligence, given the anticipated character of the future operating environment) will be key to the delivery of air and space power. There will be four requirements:

- a permanent air element of standing national command and control structures;
- deployable air command and control within a joint context;
- traditional, air component command; and
- providing modules of air and space staff expertise to support other headquarters.

### **The air element of national command and control**

353. A permanent air command element of national command structures must be configured to meet standing commitments, which may include ballistic missile defence within the concept timeframe. It should also provide the means to capitalise on air power's inherent agility to react and respond more quickly to contingencies than any other lever of national power.

### **Deployable air command and control**

354. In the future, UK-only operations are likely to be conducted by a smaller joint force, where close synchronisation of activities and effects will be necessary to generate momentum through tempo rather than mass. This favours a joint, integrated command and control structure, with embedded environmental staffs rather than stand-alone components where the joint commander exercises direct command of all assigned force elements. However, most campaigns will have an environmental bias. Consequently, a deployable air headquarters should be able to act as the core of an integrated, joint task force headquarters for small-scale national operations with an air focus. For example, an air control operation would require the deployment of an air-focused joint task force headquarters, commanded by an airman as joint task force commander, but augmented with embedded land and maritime staffs tailored to suit the specific circumstances of the campaign. However, we must configure the architecture of the headquarters



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so that it can be adapted to the component model, if the campaign subsequently develops in scale and complexity.

### **Component command**

355. The complexity and span of control required in medium- to large-scale and multinational operations means that component command will endure within this context. In large-scale coalition operations, our force elements will be unified under a national contingent commander, but operate within separate components likely to be led by other nations.<sup>27</sup> Consequently, we should continue to prepare airmen for joint task force commander, joint force air component commander and national contingent commander appointments. Similarly, air staff must be trained to operate within independent, self-sustaining, multinational component headquarters.

### **Modules of air command and control**

356. Finally, there will be a requirement to generate modules of air command and control, including individual augmentees, to staff other headquarters. This is required to meet the policy direction for simultaneity and concurrency. For example, while the Joint Task Force Headquarters (Air) is deployed to lead a small-scale, primarily air-focused operation, there may be a simultaneous requirement to augment the air staff element of other headquarters deployed on concurrent operations. These may be UK joint headquarters focused primarily in the land or maritime environments, or multinational headquarters configured around the componency model for an enduring coalition operation. Either the standing national air command element or the deployable air headquarters may be used as the focus for collective and individual preparation, generating the pool of personnel necessary to meet the requirement for trained air staff.

### **The NATO framework**

357. Wherever possible, our national command structures should comply with NATO architecture and processes. It will be easier to pull a UK plug out of a NATO socket for a national requirement than it is to force-fit bespoke national systems into a NATO construct. *Top Secret* will remain a UK and

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<sup>27</sup> Although it should be noted that the UK's NATO Response Force contribution includes responsibility for providing the Joint Force Air Component Commander (JFACC) and associated headquarters. In this case, the JFACC would also act as the national contingent commander.

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Five-Eyes<sup>28</sup> domain, but NATO *Mission Secret* should provide the backbone of our command and control architecture. We must hard-wire NATO processes and doctrine – technically and culturally – into our systems.<sup>29</sup> We should also adhere to a NATO construct, as this is most likely to allow us to use our command and control structures as enablers for less technologically or operationally capable nations in non-NATO scenarios.

### **The future air and space command environment**

358. The environment for air command will continue to develop. Situational understanding and decision superiority will remain as fundamental enablers, but networked operations will become the norm. Computer communications will underpin command and control by feeding a knowledge base that should be accessible at every level. Space will become an increasingly important feature of military operations, but the global reach of the capabilities involved means that command and control of the assets is unlikely to be delegated down to the level of headquarters responsible for regionally-based areas of operation.

### **Principles of air command**

359. Traditionally, air command has used a model of **centralised control, decentralised execution**. The increased level of access to information, and the growing ability to share understanding, offer us the potential for a more flexible system of command and control. **Centralised control** will still be required to allocate and apportion inevitably scarce air resources. However, **directed** – rather than **decentralised** – execution will become the norm, where commanders may choose to centralise or decentralise execution authority according to the circumstances of the campaign.

### **Decentralised execution**

360. A greater degree of **decentralised execution** will be possible where appropriate. This will depend on coalition participants being adequately trained, comfortable with the concept of mission command, and technically able to plug into the command network. Decentralisation allows certain command responsibilities, such as air-weapons release authority, to be delegated. This enables tactical self-synchronisation and generates

<sup>28</sup> Five-eyes refers to UK, US, Canada, Australia and New Zealand.

<sup>29</sup> *Op.Cit.*, DCDC, *How We Fight: The Role of Military Power in Achieving National Objectives*.

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increased tempo by shortening the decision cycle. It may also be the only feasible option for complex, large-scale air campaigns with many assets in play. Decentralised execution allows air commanders to concentrate on command rather than being distracted by the necessity to control. It should therefore remain the ideal.

### **Centralised execution**

361. However, the future air command environment will also enable a greater degree of **centralised execution** to be undertaken if required. This may be more appropriate in three specific circumstances:

- for small-scale missions, or those conducted by the highest-value assets, where the stakes are particularly high;
- if there is better situational understanding available in the air headquarters (or above) rather than in the cockpit or at the console; and
- if the participation of unfamiliar or less capable coalition partners means that it would be inappropriate or unwise to decentralise execution authority.

### **Directed execution**

362. The guiding principle is that execution authority should be directed to the point where the best level of understanding is available. This may be:

- in the cockpit or at the console (decentralised execution); or
- at the air headquarters, or above (centralised execution).

363. This means that every air campaign must be subject to a rigorous command estimate, so that the air commander can direct the most appropriate degree of delegation, according to the specific nature and circumstances of the campaign. Factors include the:

- kind of conflict being fought;
- stakes involved and the military and political appetite for risk;
- scale and complexity of the air operation; and
- number, type and capability of the participants involved.

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The principles of unity of command and the ethos of mission command will endure as the cornerstones of air command and control, but the principle of centralised control, directed execution should be used as the basis for a more adaptive approach to air command and control.

### **The adaptive air commander**

364. The success of adaptive air command will depend on preparing air commanders with a mature understanding of air and space power, and the circumstances of its employment. The analysis of command requirements and processes in the air estimate must be crystallised into an absolutely clear and unambiguous statement of commander's intent. Developing air commanders at ease with the demands of information-dominated warfare and full-spectrum targeting may be difficult if their experience is rooted in a different paradigm of combat and decision making. Shifting from control-based methods of air operation to a greater emphasis on command must be based on a fundamental understanding of national and multinational doctrine. This involves not just a grasp of developing technology, but also the ability to exploit the information it delivers.

365. Airmen must be prepared for two different models of command and control.

a. **Command within traditional, component-based structures for complex and multinational operations.** This demands preparation for leadership and followership – the most likely circumstance – within coalitions and a command approach that accounts for the different capabilities, constraints and sensitivities of partners and allies.

b. **Joint command of small-scale, national operations from a joint task force headquarters.** This means air commanders must have the confidence, knowledge and credibility to exercise direct command not only of air elements, but also of assigned land and maritime forces.

366. The practicalities and resource constraints involved mean that we must adopt a disciplined approach to identify and select suitable candidates for command. They must be properly educated and developed within a career stream that will not be open to all.

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## Deductions and implications – Adaptive air command and control

367. There will be four requirements for UK air command and control:
- **a permanent element** to meet standing commitments and enable the quickest response to contingencies.
  - **a deployable element**, able to act as the basis for an integrated, joint task force headquarters for small-scale operations with an air focus.
  - **component command capabilities**, for large-scale or multinational operations.
  - **generating a pool of trained staff** to augment other headquarters as required. (Paras 351-354)
368. NATO command and control architecture should act as the default for UK structures. (Para 355)
369. Command of space assets is unlikely to be delegated below the strategic level. (Para 356)
370. The developing air command environment will demand a progressive migration to a process of adaptive air command and control based on the principle of *centralised control and directed execution*. We must perform a rigorous command estimate for each campaign to determine its specific character and the appropriate degree of delegation. (Paras 360-361)
371. Collaborative working and planning will be necessary, requiring the development of information management and other decision support systems that are interoperable with other services, coalition partners and agencies. We also need to adopt a command approach that is tailored to the capability and capacity of coalition partners, both as leader and reliable follower. (Para 363)
372. We must carefully select and prepare adaptive air commanders. This will be resource-intensive and opportunities will be confined to a small number of suitable individuals. (Para 364)

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### **The balance between roles**

373. UK air forces entered the post-Cold War period based around the attack and control of the air capabilities necessary for conventional war-fighting. Since then, there has been a progressive re-balancing to reflect the different demands of a decade of enduring irregular warfare. This has involved emphasising ISR and renewing the fixed- and rotary-wing mobility and lift fleets, offset by the significant reductions that have already been taken in combat air capability. The forthcoming withdrawal from Afghanistan will mark a shift in the UK's strategic posture away from enduring campaigns towards contingent operations. This will put a premium on our ability to generate rapid understanding. It also demands a force structure appropriate for a range of different types of conflict, including maintaining an irreducible core capability across all four air and space roles to comply with the policy requirement to undertake independent military action.

#### **Combat Mass**

374. However, with the exception of the US, no nation is likely to be able to deploy the full spectrum of air and space capabilities out to 2035. This means we will have to make capability trade-offs. There will be an enduring requirement for high-performance platforms to meet the most demanding roles, but this will come at the expense of numbers. Therefore, we require innovation to restore mass. Alliances and partnerships may provide access to niche or alternative capabilities, and also force size and breadth. Role-configurable, remotely piloted and unmanned air systems, and genuinely multi-role, late-generation manned combat air platforms will also provide agility. Additionally, networked air transport platforms will contribute in the intelligence and situational awareness role and, if fitted with weapons modules, even to attack missions. However, we will not be able to fulfil every mission within each air power role. For example, a control of the air capability will be essential, but a bespoke, specialist suppression of enemy air defence capability may not be affordable as part of it. Some mitigation is possible. During the Libyan campaign of 2011, stand-off weapons were used to reduce the need for manned aircraft to penetrate deep into enemy territory, thus mitigating the lack of offensive electronic warfare and low observable capabilities.

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### **Foundation enabling capabilities**

375. Providing even the bare minimum of necessary capability across all four air power roles will absorb most, if not all, of the available resources. However, any discretionary investment should give appropriate emphasis to foundation enabling capabilities. These are essential, both to properly integrate a small, UK joint force for sovereign operations, and to provide the framework for larger, multinational operations. Only the UK and France are likely to be able to perform this role in Europe's 'near-abroad'<sup>30</sup> if the US (or an established alliance structure) is unwilling, or unable, to lead the initial phases of an intervention operation. Such enablers include command and control, ISR configured for rapid understanding, and strategic mobility. These capabilities also provide the wherewithal to support a military strategy based around early-entry and a light footprint, where combat mass and sustainment are provided by coalition partners or indigenous forces. This would potentially reduce the political, human and financial costs of intervention operations, maximising political freedom of manoeuvre and buying time for strategic patience to be built.

### **The manned-unmanned balance**

376. The advent of enhanced data networks, coupled with the development of truly multi-role capabilities, will cause the four air power roles to blur. Platforms will simultaneously undertake what were previously regarded as discrete missions. This will increase our dependence on space, cyber and electronic warfare as enablers for an evolving combat air system comprising manned and unmanned capabilities. More work is necessary to define the composition of the force-mix, but modelling suggests that a mix of one third unmanned to two thirds manned will provide the most flexibility.<sup>31</sup> A proportion of platforms will need to be capable of penetrating and surviving in hostile airspace to gain control of the air at a time and place of the joint commander's choosing. This will put the onus on survivability, currently provided primarily by electronic warfare and manoeuvre, but in the future through a layered and integrated approach using advanced, stealth-like technology with multi-spectral counter-measures. It is imperative that the combat network is interoperable with the capabilities of the other Services,

<sup>30</sup> Secretary of Defense Panetta, 48<sup>th</sup> Munich Security Conference February 2012.

<sup>31</sup> Joint Doctrine Note (JDN) 2/11 *The UK Approach to Unmanned Aircraft Systems*

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allies and coalition partners who will contribute much, if not the majority, of the total force-mix.

#### **Airborne command and control**

377. The small size of the future combat air fleet means we must direct and employ it intelligently. Although we can achieve this in part through enhanced networks, there is likely to be an enduring requirement for an airborne command and control system to promote situational awareness and coordinate activities across a joint or coalition scheme of manoeuvre. This means that scarce combat assets may be used to best effect, particularly in force projection operations, where a terrestrial ISR infrastructure may not be available. Air command and control platforms may also be used to form a group of automatically reconfiguring nodes, allowing information and data to be exchanged throughout the joint force. This is an important networking capability that will supplement the capacity of space-based capabilities, or mitigate their loss if they are degraded by natural hazards or hostile action.

#### **Sixth generation capability**

378. During much of the concept timeframe, combat air capability will be provided by fourth and fifth generation manned aircraft, supported by a smaller number of remotely piloted air systems. This force-mix is unlikely to be able to assure a persistent presence in a hostile air environment towards the end of the FASOC timeframe. The resulting capability gap could be met by a system based on sixth generation capability supplemented by a cadre of fifth generation manned platforms. The sixth generation capability may be manned or unmanned. Unmanned air systems no longer represent a particularly high development risk.<sup>32</sup> They may eventually be configurable for multiple roles and their flexibility is likely to be enhanced by modular payloads. The advantages include:

- a potentially all-synthetic training environment;
- no requirement for personnel recovery, aero-medical or combat survival capabilities;
- a reduced forward footprint; and
- more efficient buy-to-deploy ratios.

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<sup>32</sup> US Unmanned Aerial Systems Roadmap 2009.



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379. There are also significant drawbacks. These include:

- the vulnerability of control and data links and the need for effective electromagnetic domain management;
- constraints on flight in non-segregated airspace;
- airworthiness certification; and
- ethical concerns.

Future unmanned air systems must also be capable of being deployed as rapidly as the current manned fleet. At present, airspace control issues and the infrastructure investment required to operate remotely piloted air systems constrain their global responsiveness. Finally, the cost of unmanned systems may not be markedly lower than for comparable manned systems. For example, capabilities such as *Sentinel* and *Shadow* have proved to be highly cost-effective in the ISR role, albeit in specific operational circumstances. However, many of the inhibitors to change are now cultural rather than technical or financial.<sup>33</sup> The rapidly-maturing technology levels indicate that our current fourth generation-plus combat air capability could be replaced by an advanced unmanned system by 2035. This will only be possible if a viable, coherent and adequately resourced development strategy is agreed in the near-term.<sup>34</sup>

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<sup>33</sup> *Op.Cit.*, DCDC, *How We Fight: The Role of Military Power in Achieving National Objectives*.

<sup>34</sup> To include a new industrial and military approach to support the platforms in service.

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The future delivery of air and space power

### **Deductions and implications – The balance between roles**

380. The shift in the UK's strategic posture demands ISR configured to develop quick understanding, and a force structure suitable for a range of different types of conflict. However, we must maintain an irreducible core capability across all four air and space roles to underwrite our ability to take sovereign military action. (Para 371)

381. We will have to innovate to compensate for our lack of combat mass. Although a range of potential measures are available, ultimately it is unlikely that all the shortfall can be addressed, so mitigation will be necessary. (Para 371)

382. Any discretionary investment should emphasise the foundation enabling capabilities that provide the framework for joint and combined operations. (Para 373)

383. Future combat air capability should be based on a systems approach rather than individual platforms. (Para 374)

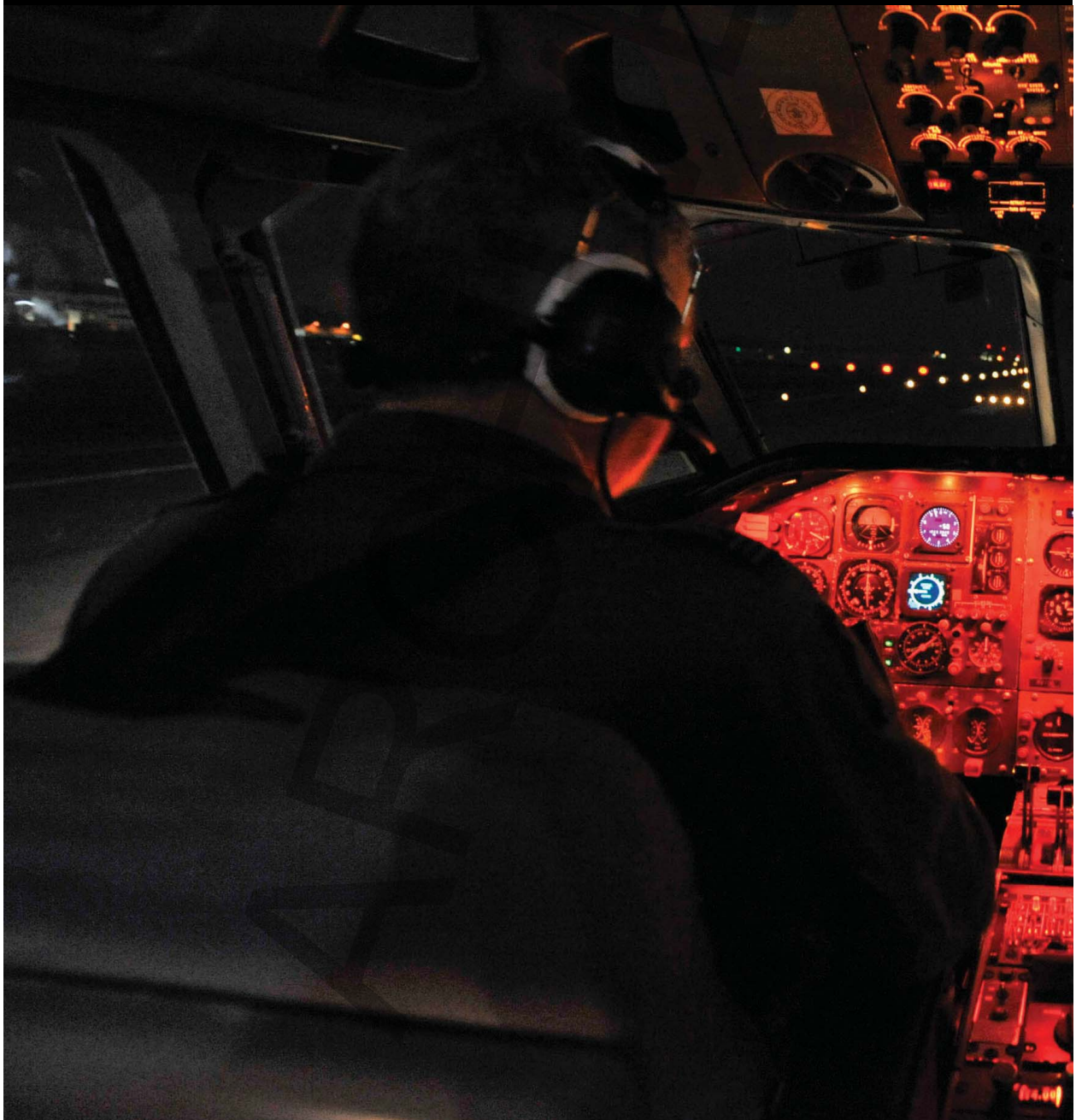
384. An airborne command and control capability is likely to be required to maximise the usefulness of the small combat air fleet. (Para 375)

385. Beyond 2030, combat air capability should shift to a force-mix based on sixth generation capability. Some of the deficiency in mass may be bought out by using larger platforms to act as weapon carriers and a balance of conventional and novel weapons synchronised with electronic warfare and cyber capabilities. (Paras 376-377)

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# Conclusion

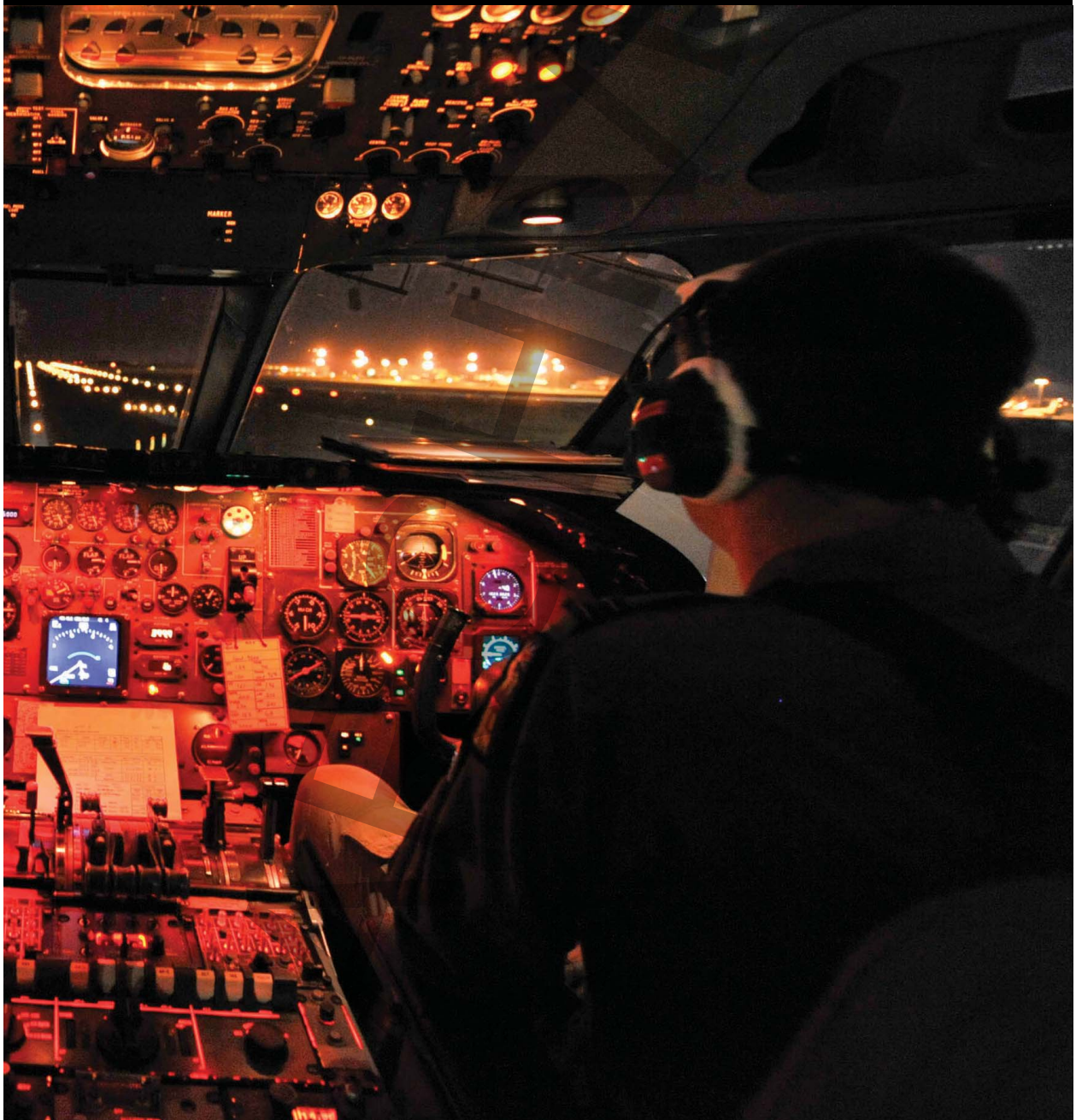


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*Not to have an adequate air force in the present state of the world is to compromise the foundations of national freedom and independence.*

Winston Churchill



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## **Conclusion**

The next two decades are likely to be hallmarked by uncertainty, complexity and volatility. In parallel, the character of warfare will continue to evolve. Consequently, UK air forces must be configured to operate across the spectrum of conflict, from the most likely to most complex operating environments. This will include a threshold capability across all four air power roles (although not necessarily in every specialist mission within each role) to underwrite the UK's sovereign ability to take independent military action. It will be difficult to identify specific threats and optimise capabilities to defeat them. Instead, as a contingent force at readiness, we should develop our ability to adapt to unforeseen circumstances and close any gaps – conceptual, or in terms of capability – rapidly. Within this context, understanding will be a critical enabler and our intelligence, surveillance and reconnaissance capabilities will be vital if military power is to be applied coherently and effectively.

The ability of our air and space forces to protect the UK provides reassurance and underwrites our political freedom of manoeuvre. Additionally, air power's inherent capability to project military force is an important source of hard power. Accordingly, our air and space forces will contribute to national security in two ways. First, through deterrence, conflict prevention and capacity-building (through engagement with allies and emerging partners). Second, *in extremis*, through warfighting operations in the nation's interest. In delivering these roles, technology will be important, but the whole capability package will matter more than the quality of individual platforms. We need to develop a flexible and well-integrated, networked combat system. This should comprise a mix of sufficiently capable manned and unmanned platforms that are available in adequate numbers, supported by an accessible weapon stockpile that can be replenished within operationally useful timescales. There should also be the potential for regular upgrades through spiral development or the modular insertion of new technologies.

Although this operating concept has focused on the distinctiveness of the air and space environments, air and space power is most potent when operating within an integrated, joint scheme of manoeuvre, underscored with civil support from the Ministry of Defence and other government departments.

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## Conclusion

We can expect to fight as part of a small, but closely integrated, joint force, most likely in alliances and coalitions (with NATO as the default) or, exceptionally, in UK-only operations. The effectiveness of the joint force will largely depend on a rationalised command structure that embeds a culture of integration, enabling it to train effectively as a contingent force at readiness rather than an amalgam of individual force elements. Integration must be cross-dimensional, not just joint. The information domain (including cyber), space operations and the electromagnetic domain are likely to become as important as military activities in the more traditional environments of air, land and sea.

FASOC has therefore been developed with its two companion Service operating concepts and coordinated with the new Joint Operating Concept to ensure that a coherent view of warfare development is reflected across all three fighting Services. The principles it describes will serve as the basis for discussions with our principal allies and relevant partner agencies for future operations that are likely to be combined, joint, intra-governmental, inter-agency and multinational.